SHORT TERM ANALYSIS OF VARIOUS USES OF CANCELLOUS FEMORAL HEAD AND CORTICAL ALLOGRAFTS AND THEIR FUNCTIONAL OUTCOME IN ORTHOPAEDIC SURGERY

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CERTIFICATE

*This is to certify that this dissertation entitled "***SHORT TERM ANALYSIS OF VARIOUS USES OF CANCELLOUS FEMORAL HEAD AND CORTICAL ALLOGRAFTS AND THEIR FUNCTIONAL OUTCOME IN ORTHOPAEDIC SURGERY***" is the bonafide work done by* **Dr. S.P. YOGANANDAN***, under my direct guidance and supervision in the Department of Orthopaedic Surgery, Madras Medical College, Chennai-3 during his period of study from February 2003 - October 2006.*

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CONTENTS

INTRODUCTION

Bone is the most commonly transplanted tissue in our body than any other tissue or organ except blood. Approximately 5,00,000 bone transplantations occur in USA every year. For every ten heart transplantations, of twenty five kidney transplantations, hundred bone transplantations occur world wide.

Bone is a unique tissue in the ability to regenerate is more predictable than any other tissues. In the body autografts remain the gold standard as they are osteoconductive as well as oseto inductive and have osteogenic cells. Most of the time, the amount of graft required is small and harvesting bone from iliac crest & fibula is enough.

Autografting has many disadvantages such as additional blood loss, increased operative time and cutaneous nerve damage, persistent pain at the donor site, vascular injury, and iliac bone fracture, herniation into the defect and in additional morbidity. Also the amount of morbidity is in direct proportion to the quality of graft retried. When the graft requirement is larger as in children where risk of damage to growth plate is high, revision hip surgeries, traumatic bone defects, spiral fusion and decompression surgeries, allograft comes into play.

Bone defects in tumor cavities, traumatic bone defects are treated by various methodologies such as

1. autografts, vascularized and non vasvularized
2. bone cementation(tumors)
3. implants
4. biomaterials ceramics
5. synthetic bone substitutes
6. demineralized bone matrix and bone morphogenic protein
7. bone allografts

Allografts have several advantages such as easy to obtain of enormous availability (theoretically) of the graft, ↓ donor site morbidity, availability in all dimensions, cheaper than metallic implant, biolologic form of fraction (i.e.) after incorporation, the allografed area achieves the quality of the bone and can be stored for long time, up to 6 years in case of freeze dried allografts and for 5 years for deep frozen allografts.

The clinical application of bone allografting became prevalent in the first two decades of the 20th century after experimental work of Ollier and Axhauen. From then on various forms of bone allografts are being used with variable success.

Allografts of are used in various forms like morcellized allografts, osteochondral and intercalary allografts for various defects. Femoral head allografts can be harvested form donor undergoing primary THA or TKA, and can be stored processed and used in another patients.

Bone allografts may be used as

- Fresh bone – it has a limited use
- Frozen bone – freezing does not adversely affect strength of allograft and also reduces immuogenicity while retaining sufficient osteoinductive potential
- Freeze dried bone – freeze dried in vacuum. It has the advantage of storage at room temperature, long shelve life but resorbtion rate is high of bone become brief with little osteoconductive ability.
- Demineralized bone – prepared by acid treatment of bone of remove in organic minerals. It has no structural strength, high resorbtion rate also osteoinductive potential. It has only limited application in situation where large gap has to be filled.

Cancellous bone or morcellized cortical bone is most often used for filling cysts or cavities, cortical bone is optimal for reconstructing defects the require a certain from and strength.

Although technique for allograft bone storage was described in the late 1940s and whole segmental grafts were used for tumor surgery in 1960s, the use of femoral head allografts as structural bone grafts was started in 1976 for revision hip surgeries. Initially, bone grafting was performed most commonly during complex primary hip arthroplasties such as for dysplasia, Protrusio acetebuli etc; currently for revision hip arthroplasty, foot and ankle surgeries, tumors and fracture non unions.

The technique and practice of bone allografting in India is yet to take a firm footing. The facility for proper processing of the harvested bone allografts, its storage and strict donor screening is available only at few tertiary heath centers in India.

The bone bank in government General Hospital started in the year 2005 is one such place aimed at maximal utilization of the allografts.

Very few studies till date are available regarding the various uses of (femoral head bone) allografts in orthopaedic surgery including trauma, tumor, revision hip arthroplasty, spine, foot and ankle surgeries etc.

Our study is one such study bringing out the various uses of bone allografts in orthopaedic surgery.

AIM OF THE STUDY

1. To analyze various the uses cancellous and cortical allografts in orthopaedic surgery

2. The functional outcome of the allografts in these conditions.

HISTORY OF ALLOGRAFTS AND BONE BANKING

3000 yrs ago – Mythological saints Cosmos and Damien performed total replacement of a leg of a black man to a white man.

Sushrutha 2500 yrs – Used various skin and bone allografts and nasal bone reconstruction.

1682 - Jole Van Meekren – Russian Church records a successful use of piece of dog skull to repair a defect in the skull of the soldier.

William Maceman (1881) Glasgow

- First successful bone allograft
- Started the modern practice of bone grafting
- Successfully transferred segments of bone from a rachitic patients to the humerus of a three year old child suffered from osteomyelitis
- Rib grafts to replace mandible

- 1893 - Barth – Concept of creeping substitution
- 1908 - Lexer – 25 allogenic whole joint transplantation.
- 1908 - Axhauser – Supports the view that repair of bone defects and replacement of bone grafts are affected by deposition of bone by periosteum and the endosteum.
- 1914 - Phemister – Technique of bone grafting to enhance the process of creeping substitution

- During World war time

- 1935 – 1937 Bush & Wilson – Bone storage at 10° to 20° C in New York.
- From 1940 - 1970 – M. Volkov Russia – Successful procedures using processed bone
- 1941 – H.B. Boyd – fresh bone allografts in the treatment of pseudoarthrosis
- 1942 – Inclan – storage of autogenic and allogenic bone
- 1948 – M.O. Henry

  - Fresh bone allografts procured from the parents in the treatment of cysts and tumor.

- 1952 – US Navy – George Hyatt – Founded Navy Tissue Bank
- 1952 – First tissue bank by Rudolph Klen at Faculty hospital at Hardee Kralore Czechoslovakia.
- 1956 - Albee, first orthopaedic surgeon started US bone bank in New York.
- 1960's – Ethylene oxide sterilization has been used for bone
- 1961 - Goser coined the term Allograft.
- 1965 - Mohammed Al Gafeqin of Cordoba – advocating spinal fusion using fish bones.

- 1974 - Radiation sterilization focus to be an alternative for Ethylene Oxide sterilization on the grounds of safety and cost.
- 1978 - Burchandetal – Described three patterns of allograft incorporation
- 1980 - H.J. Martin at Massachusetts – Active programme for allografting
- 1983 - W.W. Tomford – Use of Glycerol and Dimethyl sulfoxide to maintain the viability of cartilage during freezing.
- 1987 - G.E. Friedlaender – Current concepts review, bone grafts, basic science rationale for clinical application.
- 1989 - M.R. Urist – Bone Morphogenic Protein bone regulation, heterotopic ossification and bone marrow consortium.
- 1990 - International Atomic Energy Agency published guidelines for the radiation sterilization.
- 1990 - 30 Tissue banks US

  - 31 Tissue banks in Europe.

- P.H. Custus, S.W.Chare, C.H. Herdone – suggested freezing the cadaveric bone reduces the Immuno – genicity.
- Dr. F. Langer Canada – Reaction to allografts was greatly reduced by freezing the grafts

Femoral head allografts

The use of femoral head allograft as structural bone grafts was started in 1976. The earliest reported use of structural bone grafting in hip replacement was 1973 by Horn's et al[1].

In 1978 McCollum and Nunley showed the potential of Morcellized allograft to that bone stock deficiency in protorsio acetabullum[2]. In 1983 Roffman et al reported the survival of bone chips under a layer of bone cement. In a study of animals[3] the graft appeared viable and new bone formed along the cement interface.

In 1984, sloof et al., described the technique of impaction bone graftiy[4].

BIOLOGY AND INCORPORATION OF ALLOGRAFTS

A successful bone graft has to incorporate into the skeletal system of the host. Graft incorporation depends on its size, structure, position, fixation and genetic composition. The role of the grafts in stimulating incorporation encompasses osteconduction, osteoinduction and osteogenesis.

Osteoconduction and creeping substitution are the main mechanisms in the incorporation of allografts. Allografts act as a scaffold for in growth and it is referred as osteoconduction.

Graft incorporation occurs in following stages

1. Revascularization
2. Graft resorption
3. Creeping substitution, new osteons laid over the Allograft.
4. Graft remodeling

Revascularization occurs by invasion of the capillary sprouts form the host bed and resorption of the old matrix follows with the investing osteoclasts & osteoblasts around the blood vessels that invade the graft.

After the Osteons are laid, callus formation ensures around the allografts serially which remodels in the course of time to ensure adequate incorporation.

Large allografts may be incorporated in processing serial stress fractures that result in graft remodeling; periodically a region of stress concentration may microfracture followed by local remodeling. Later it proceeds to the whole length of the massive allografts. It takes a long time for the massive allografts to get incorporated into the skeletal system of the host.

Major type of allografts and their incorporation

Major types of allografts are

1. Demineralized bone matrix allografts
2. Morsellized and cancellous allogenic bone
3. Cortico cancellous and cortical allograft
4. Massive allogenic osteochondral allograft.

1. Demineralized Bone Matrix

It gets quickly revascularized and provides no structural support and moderately osteoinductive also. Within 1 hour, Implantation is followed by platelet aggregation, hematoma formation and inflammation characterized by migration of leucocytes.

Fibroblast like mesenchymal cells undergoes cellular differentiation into chondrocytes around 5 days. Chondrocytes produce cartilage matrix, which is mineralized. After 10 -12 days vascular invasion with osteoblastic cells and new bone is formed opposite to the surface of the mineralized cartilage. Remodeling and replacement of these compound structures with new host bone ensues. With time, all the implanted DBM is resorbed and replaced with host bone.

2. MORSELLIZED AND CANCELLOUS ALLOGENIC BONE

Limited mechanical support and are osteoconductive only. Derived from either cancellous or cortical bone ranging from chips of sizes 0.5 to 3 mm diameter. They are characterized by an open, porous almost lattice like physical structure so that there is no physical improvement to the in growth of vessels.

The same stage of hemorrhage, inflammation, vascular ingrowth, osteoid formation, remodeling and graft integration as in case of allografts take place. They are osteoconductive only and more resistant to compression. This may act as weight bearing structures during the process of graft incorporation. They do not suffer the transient loss on mechanical strength that as resorbtion is not necessary for revascularization.

3. Corticocancellous and cortical allografts

They provide structural support and osteoconductive to a limited degree. The process of incorporation is slower than the DBM and cancellous allografts as resorption is necessary for revascularization.

Massive Allografts

The incorporation of massive allografts is a slow and incomplete process. Immune response is produced by the host even through the long storage in the deep freezer in order to reduce the immunogenicity. New bone formation from the periosteum of the host bone at the host graft junction is essential for the union at allograft host junction. Creeping substitution and graft remodeling occurs in the slower phase and taken long time in achieving fusions.

IMMUNOLOGY OF BONE ALLOGRAFTS

Organs and tissues transplanted into host incompatible animals or humans will induce an immune response. There is substantial evidence that bone, like other allogenic tissues, also induces such a response as a result of the recognition of a variety of potential alloantigen by the host's immune system. These antigens are capable of stimulating the full range of immune activities including cellular responses, antibodies and cytokine release.

IMMUNOLOGICAL COMPONENTS

Bone is a complex tissue comprised of many constituents capable of acting as sources of antigen. These include the non-cellular antigens of the extra cellular matrix such as collagen together with non-collagenous proteins (proteoglycans, glycoproteins, etc.) as well as cells that express the major histocompatibility antigens. The primary causes of the host immune response in bone allograft transplantation are the cells of the bone marrow, primarily leukocytes. Reduction or removal of such cells by processing, freezing, freeze-drying or irradiation reduces these cellular elements and thus lowers the likelihood of an immune response.

Several studies have demonstrated that after transplantation of frozen bone or soft tissue grafts than an immune response is generated causing antibody formation in up to 75% of the patients. This does seem to affect the outcome of massive bone transplantation. For tendon allografts it does not seem to have clinical importance. Transplantation of freeze-dried grafts does not cause antibody formation. Freezing and freeze-drying procedures decrease the antigenicity of bone. Irradiation of bone not only sterilizes the bone but also destroys its antigenicity.

HISTOCOMPATIBILITY MATCHING

Experimental results show that matching does reduce immunogenicity and improve the outcome of bone allografts. However, its potential benefit in clinical practice is still controversial and unresolved.

ALTERING THE GRAFT

The selective manipulation of grafts prior to transplantation helps prevent rejection without totally suppressing the immune system. This method not only reduces immuogenicity but also solves the problem of storage methods for grafts. Some methods of alteration are freezing; freeze dying, autoclaving, deprotenization, decalcification and exposure to high doses of radiation.

GRAFT PREPARATION

Material

The original technique of impaction bone – grafting described by Sloof et al. involved the use of morsellized cancellous bone[4]. The argument for using cancellous bone as the base material was that the open structure of cancellous bone would allow more rapid angiogenesis of that the opposition of cancellous trabeculae would enhance osteoclast – driven remodeling[5,6]. Although cortical allograft might weaken during the resorbtion phase, it will still remain stronger than cancellous graft[7.]

Several investigators have tried to optimize the mechanical performance of morsellized bone graft under compaction by manipulating the particle size and the range of sizes (the grade) as well as by supplementing it with particle of other materials that are stronger of stiffer than bone[9]. A combination of relatively large particles (x2mm) and a strong base material achieved better mechanical stability.

Henmann and Finlayson (2000)[8] analyzed the convention of ordering bore from the tissue bank in terms of numbers of the femoral heads. Authors state that this approach results in great variability in the quantity of graft available for impaction because of the variability in size of density of femoral heads. This variability may compromise the stability of the impacted graft of recommended requesting the allograft by weight not quantity, which predicts more accurently the volume of graft after impaction.

MORSELLIZATION

The size and grade of the bone particles is important to the early mechanical stability of compacted morsellized graft. The general consensus is that the particle should be as large as practical to ensure stability. Another advantage of larger particles is that they result in a more porous the more permeable compacted bone graft. Dunlop et al. 2003[10], suggested removal of fat and marrow fluid from milled femoral head allografts by washing the graft which allows the production of stronger compacted graft that is more resistant to sheer as it is the usual mode of failure. Shear strength of the graft layer is improved by using morsellized graft with fine particles. However, using this range of particle sizes reduces graft permeability, since the pores between larger particles will be filled with smaller particles.

RINSING

Fluid plays an important role in compaction[11]. By simply washing the graft with a warm saline to remove the excess fat, the force required to displace a grafted implant can be almost doubled[12]. Rinsing may further enhance stability by improving the shear strength of the graft[13.] Processing the grafts to remove blood fracture elements improve both the clinical performance fracture safety of these allografts which involves pasteurization, centrifugation, and sonication and repeated washing in warm distilled sterile water[14]. Removing lipid from the grafts has been shown to increase the rate of incorporation[14].

The Contamination of the graft is a concern during pulse lavage. The real contamination is low at least after pulse lavage washing of the femoral head[15]. Pulse lavage washing along with sterile saline solution can be recommended for allograft decontamination[16.] With rinsing the total tissue ingrowth increased in the allograft group to approach that of autografts in a study (Vander Donk et al., 2003)[17] . Rinsing after impaction did not additionally alter bone ingrowth.

STERILIZATION

There are varieties of sterilization methods available as described below.

1. Physical method – autoclaving
2. ETO sterilization
3. Radiation sterilization

Physical methods though are not the recommended, because of its deleterious effects on the biomechanical properties of bone and soft tissue, it has been suggested that exposure of 56°c for 30 min may be sufficient to inactivate most cells including HIV.

Moderate heat treatment of bone allografts of 65°c has less adverse effects on osteointegration in rabbit femoral condyl (Kuhne et al 1992[18]). Knaepler noted no effect at 60°C, diminution of yield point and maximum stress at 80°c, while all measured biomechanical parameters were severely affected to 60% of control at 100°c (1990 – Biomech knaepler et al of all organite[19]).

Even though strict donor screening programmes are carried out, these measures do not definitely rule out the possibility of HIV transmission as there is a window period before infection is revealed by blood testing. Accordingly there is a need for virus inactivation methods and moderate heat treatment and autoclaving are viable options for allografting in countries where there is difficulty in obtaining large quantities of fresh freeze allografts.

EXPERIMENTAL FINDINGS

Heekin et al (1995)[20] in a post mortem retrieval analysis of morsellized allograft used for acetabular reconstruction showed that at 18 months vasvularized tissue had penetrated the allograft fragments to a depth of 4mm in peripheral area, the vascularized in growth was accompanied by partial osteoclastic resorption of graft trabeculae and application of living bone to allograft fragments. After 53 months in situ, graft fragments had remodeled and showed progressive vascular ingrowth and by 83 months graft almost completely incorporated.

CLINICAL RESULTS

Morcellized cancellous bone grafting dates back to early 60's and 70's Spence et al 1969[21] in a study has treated 177 cases of simple bone cyst at various site with freeze – dried cancellous bone allografts has showed good results in most of his cases. Delayed union and bacterial infection were the main problems necessitating repeat procedures.

Spence et al and Bright et al 1976[22] has treated 144 cases of solitary unicameral bone cyst with curettage and packing with freeze dried crushed cortical bone allograft, has showed 88% of healing rate in those cysts that were completely packed. High rates of recurrences were seen in young patient (10 years) active cysts in females and in completely packed cysts data shows freeze – dried allogenic crushed cortical bone is superior to similarly processed cancellous bone and comparable to cancellous autografts.

Gordon et al 1985[23] performed total hip arthroplasty in 13 hips with acetabular bone grafts for secure component fixation. The incorporation and healing of acetabular bone grafts were investigated with aid of roentgenogram, planar bone scans and 3D spect. The conventional radiographs proved unreliable in evaluating because of overlapping of trabecular pattern. There was no evidence of graft failure or acetabular loosening. Bone graft during late follow up exhibited normal nucleotide activity while fresh graft < 1 year showed increased activity.

Oakeshott et al (1987)[24] used irradiation sterilized – 70 degrees frozen allografts in 72 patients who were available for follow up study in a prospective analysis of allograft revision total hip arthroplasty. Clinical objectives were achieved in 85% of patients with a follow up period ranging from 6 -72 months.

Jaffee et al (1990)[25] treated 7 patients with benign lesions of femoral head and neck with curettage and fibular strut grafting in conjunction with a sliding hip screw. He had excellent functional result in 5 cases and fair in 2 cases. This construct with fibular strut and sliding hip screw provides strength and prevents deformity and fracture though it does not eradicate the disease. Internal fixation promotes union of the cortical graft to host cancellous bone and eliminates the need for plaster casts.

Berry et al (1991)[26] used bone allografts to reconstruct deficient acetabular and femoral bone in 18 patients during two-stage revision of a hip arthroplasty that had failed due to infection. At a mean of 4.2 years after reimplantation, only two patients had recurrence of the infection. Four patients needed another revision arthroplasty for reasons other than infection, these results suggests that allograft of bone were useful for the reconstruction of osseous deficiencies in carefully selected patients who have a hip arthroplasty after infection.

Sethi et al (1993)[27] treated 17 patients with benign cystic osseous lesions by curettage and grafting using allogenic decalcified bone. The time of adequate incorporation of the graft varied form 6 – 9 months in children and 9 – 15 months in adults. The overall response compares favorably with that to allografts from bone banks.

Proporsky et al 1994[28] described that multiple revision of the acetabulum ultimately lead to severe loss of bone stock and each bone loss type requires a specific method of allograft reconstruction to achieve acetabular component stability. In a series of 316 acetabular revisions in which 69 required support allograft, good to excellent results were seen at 5 years follow up in 76% of patients.

Buttermann et al 1996[29] reviews their experience with allograft bone in spine surgery and the results reported in the literature. In anterior cervical spine, interbody allografts have been used most successfully in single level fusions. For thoracolumbar deformity, posterior allograft with instrumentation gives satisfactory results in pediatric but yields inferior results in adults unless combined with an anterior fusion. Fresh – frozen allograft bone has been shown to have higher fusion rates than freeze dried allograft (ethylene oxide) allograft sterilization has shown uniformly poor results for anterior interbody fusions, structural allografts such as femoral ring allografts, have been used successfully to maintain interverterbral distraction, despite delayed incorporation.

Shin et al and Cheng et al (1996)[31] treated 25 patients with benign lesion of the femoral neck or trochanter with pathological fracture in 11 cases. They were treated with curettage and bone grafting with sliding hip screen and plate. The bone grafting included deep frozen allogenic cortical strut with autogenous iliac cancellous bone to fill the remaining defect space after lag screw and cortical strut had been implanted. All patients had good bony healing and incorporation of the implanted graft with excellent functional result.

Shin et al (1997)[30] treated 16 patient between the ages of 11 and 16 years with benign lesion of the humerus. They were treated with subtotal excision or curettage and allogenic cortical strut associated with or without cancellous bone grafting. There were no local recurrences or fractures of the shaft or allograft implants. The overall functional results were good and excellent and this reconstruction with biologically safe and active material provided increased strength and prevented refracture.

Still et al and Haung et al (1998)[32] treated 22 patients with fibrous dysplasia in the femoral neck or trochanter with curettage and bone grafting with a sliding hip compression screw. Bone graft included deep frozen allogenic cortical strut and cancellous allografts. All patients had good bone healthy and complete incorporation.

Shin et al and Chen et al (1998)[33] treated 104 patient with aggressive benign bone tumors by wide bone and soft tissue excision for adequate local control and the large defects were managed with deep frozen (-70°c) cortical strut allografts with or without allogenic cancellous bone grafts. They had demonstrated complete incorporation of allogenic implant and new bone formation in the cavity in 83% of the patients. All fractures healed. Good or excellent functional results were found in 97% of the patients.

Guile et al (1998)[34] reviewed the long-term outcomes of treatment of fibrous dysplasia of the proximal femur in 22 cases (27 femora) Curettage and cancellous or cortical bone grafting did not appear to have any advantage compared with osteotomy alone in symptomatic lesions as all grafts resorbed with persistence of the lesion. A satisfactory clinical result was achieved in 20 patients (9 – mono osteotic and 11 – poly osteotic disease). Poor results were with those presented with endocrinopathy. Varus deformity was treated with valgus osteotomy with or without medial displacement.

Douglas et al (2000)[35] suggested bone allografting has become an integral part of many lumber spine surgeries recently fresh frozen and freeze - dried allograft alone are used. Allografts are well suited for reconstructive procedures when used anteriorly and have good fusion rates, especially if combine with posterior fusions.

Woodgate et al (2000)[36] described a minor column (shelf) allograft as graft used for uncontained defects that involve less than 50% of the acetabulum. Authors reviewed records of radiographs of 47 patients (51 hips) who had undergone minor column structural acetebular allograft reconstruction during revision hip arthroplasty. The purpose was to identify factors that may influence the longevity of the allograft the study revealed that the acetabular abduction angle was not a predictor for failure and good results can be achieved with structural acetubular allograft especially if there is restoration of near normal hip biomechanics.

Thein et al (2001)[34] studied mid-tem result of bone impaction grafting using freeze-dried bone in 7 acetubular revisions operated between 1989 and 1994. All 7 patients were followed annually at final review (March 2000), one hip had revision performed for septic loosing 5 years after the previous septic loosing. Radiographically the freeze dried allografts seemed to incorporate in all cases but the infected one, progressive radiolucent lines were not seen, although 1 case had a stable line 1 zone. The overall survival rate for the 7 acetebular reconstructions at an average follow up 7 years was 86%. At mid term follow up there was no aseptic loosing.

Somer et al (2002)[38] reported acceptable results in the median to long term follow up of 61 consecutive cemented acetabular revision in which block allografts were used to reconstruct large defect. After a mean follow up of 6.5 years, they observed satisfactory results when grafts had been rigidly fixed additional button plate was found to improve the outcome cup migration had a 56% predictive value for failure. There was a good improvement in functional outcome which did not deteriorate up to a maximum follow up of 11 years.

Cuckler (2002)[29] recommended that when >or = 50% of the acetabular host bone is intact and stable; a press fit ingrowth socket offers a reliable solution. In the presence of peripheral, central or combined defects a reconstructing with compacted cancellous allograft is advised.

Vaccaro et al. (2002)[40] discusses the advantages of allograft tissues and cage devices in anterior spinal reconstruction for trauma in the absence or minimization of donor site morbidity and unlimited choices of graft shapes and sizes. Osteoinductive matrices often are added to these grafting alternatives to improving healing rate and success. Allografts and Cages seem to be the most frequent grafting materials used in the thoracolumbar region.

Aro et al. (2003)[41] discuses the various areas of allograft usage such as, oncological limb-salvage surgery, Revision Hip replacements, Traumatic bone defects etc. He suggested the use of Autografts at the graft host junction for induction of repair in cortical grafts. Infection of allograft is a disastrous complication. Nonunion, fracture of the graft are other complications. Osteochondral allograft show gradual deterioration of the articular cartilage with the necessitating occasional resurfacing.

Jaffe et al. (2003)[42] has treated fifteen patients with benign lesion of the proximal femur by intraletional curettage and fibular cortical allograft strut in conjunction with sliding Hip screw. Clinical results were evaluated using the functional evaluation of reconstruction procedures described by the Musculo skeletal tumor society. Clinical results were excellent in all these patients. Radiographic assessment of the patients showed no evidence of recurrence of tumor, fracture or graft resorption at the most recent follow up.

Lobo Gajiwala and Agarwal (2003)[43] has treated 41 cases of Benign and malignant bone tumors with indigenously procured, lyophilized, irradiated bone allografts. Of the 25 cases available for follow-up complete incorporation of graft was seen between 6 and 9 months in all 21 cases, in whom the allograft was used in contained cavities. 5 cases had sterile post op drainage, went on to uneventful recovery. 10% had deep infection. Autogenous marrow or autograft was used to provide Osteoinductive properties. They concluded that in selected cases the lyophilized, irradiated bone allografts proved to be very useful.

Shunmugam Govender et al. (2002)[44] treated 41 patients with caries spine and Neurological deficit by Radical anterior decompression, and anterior column was reconstructed with fresh-frozen femoral allografts and stabilized with a single-rod screw construct. Antituberculous therapy was administered for 12 months and complete neurological recovery occurred in 32 patients. The incorporation of allografts commenced between 12 and 18 months. Fusion and remodeling was observed in 33 patients and partial remodeling with fusion was observed in 8 patients at a mean follow up of 6.4 years. Forty two percent correction of the Kyphosis was achieved and there was no case of fracture or late sepsis. Fresh-Frozen allografts and anterior instrumentation are superior to rib grafts in supporting the anterior spinal column and although fusion occurred late the graft remained stable.

Lin-Hsiu Weng et al. (2004)[45] has treated 18 patients who had nonunion of fracture femur with internal fixation and autogenous bone grafts and cortical stunt allografts. The average follow up was 32.2 months. They had under gone 1.8 operations on an average before surgery. All 18 nonunions had healed on an average period of 8 months no significant complications were encountered except for screw irritation and protruding grafts necessitating additional procedures. Strict adherence to the principles of the treatment of nonunion and addition of strut allografts to enhance stability and repair potential proved to be a good alternative.

Van Houwelingen et al. & McKee et al.(2005)[46] treated 6 cases of osteopenic Humeral shaft non unions with compression plating humeral cortical allograft stunts and bone grafting to stabilize the shaft nonunion. Union was achieved at an average of 3.4 months (range 2-6 months). This method using onlay allograft stunts can provide an effective alternative in the management of humeral shaft non union complicated by severe osteopenia of various etiologies.

Basarir and Selek et al. (2005)[47] have treated bone defects after resection or curettage of musculoskeletal tumors with structural fibular autografts or allografts. This study compared the clinical and radiological results of nonvascularized fibular auto and allografts. 57 patients were treated by this method with autografts in 30 and allografts in 27. Internal fixation was used in selected cases the results were evaluated with respect to union, time of union and complications. Radiologically union was obtained in 80.7% cases with a mean of 5.9 months (6.8 months in 20 autografts and 5.1 months in 26 allografts) non union (19.3%) in 4 allografts and seven autografts. Reconstruction of cavitary and segmental bone defects with autologous or allogenic non vascularized fibular grafts is a reliable method and no significant difference was found between auto and allograft in terms of union ($P>0.05$).

ON Nagi[49] was compared the use of formalin preserved bone allograft in the form of a paste and as bone chips in fresh femoral shaft fractures with communication in 20 cases and found that the bone chips had 80% good to excellent result (Union) and they take an average period of 6.5 months (range 58 months) for fracture union. They suggested that the formalin preserved bone chips may be better suited for use in bony cavities and joint replacements, while formalin preserved bone chips are a good alternative to bone autografts, especially in poly trauma.

MATERIALS AND METHODS

Between February 2003-October 2006, 38 cases of cortical and cancellous allografting has been carried out at the department of orthopaedics, Govt. General Hospital, Chennai. This was a prospective study conducted in 38 patients, 22 of which were males and 16 were females. The Age groups of these patients were ranging from 6-55 years.

Lesion	No. of Cases
Benign bone tumors	21
Trauma cases	12

Spine	3
Revision Hip arthroplasty	2

Benign bone tumors were 21 cases of which the histopathological diagnosis was

Fibrous dysplasia in 7 cases.

Giant cell tumor in 4 cases.

ABC in 2 cases

Chondroblastoma in 2 cases

Chondromyxoid fibroma in 1 case

Simple bone cyst in 2 cases

Osteochondroma with fracture in 2 cases and

Chondroma 1 case

Among the trauma cases there were

Femoral non unions - 6 cases

Non Union of tibia - 2 cases

Non Union of Humerus - 1 case

Calcaneal fractures - 3 cases

Among spinal conditions posterior instrumentation and fusion was done in 1 case and 2 cases of caries spine lumbar level for which Anterior decompression and femoral ring allografting were done with or without instrumentation. Two cases of revision hip arthroplasties were done.

Pre Operative Assessment

Each patient was clinically assessed in the preoperative period, the data obtained included in addition to the demographic data, patient's symptoms, clinical findings and details of prior procedures if any.

In the benign bone tumor cases preoperative workup included conventional radiographs, CT scan and MRI scan in affordable patients and biopsy by percutaneous (FNAC or core needle biopsy) or open method were done. X-ray chest and if needed CT chest were taken to rule out pulmonary metastasis in selected (GCT) cases.

Femoral, tibial and humeral nonunions were assessed for any active foci of infection, discharging sinuses and number of previous procedures. Radiographs were taken for then as a part of preoperative workup.

Scoliosis spine was assessed with flexion, extension and lateral bending X-rays. Caries spine cases were worked up for pulm. Tuberculosis with DC, ESR, Mantaux, sputum AFB and culture. Transpedicular biopsy under C-arm guidance was done for these cases to confirm the diagnosis.

Revision Hip and Calcaneal as were assessed with clinical data and X-rays. Calcaneal fractures were analyzed with Bohlers angle and critical angle of Gizzane.

Traumatic bone loss cases were assessed with X-rays and CT Scans.

Management protocol

As a rule all the patients were screened for HIV, HbsAg and HCV pre operatively.

The Benign tumors were graded with Ennekings staging and based upon their grade either extended curettage in grade I and II or Marginal resection in Grade III was done. The defects were treated with cancellous femoral head allografts with or without fibular stunt grafts either autograft or allografts with or without implants.

Traumatic bone defects were treated with cortical stunt grafts (femoral, tibial stunts) and fixed with dynamic condylar screws.

Femoral and tibial non unions were treated as for any non union by freshening the fracture ends, opening the medullary canal and the fracture site was packed with cancellous femoral head grafts with some form of internal fixation.

In revision hip – the whole femoral Heads after removing the articular cartilage were used to fill the cavitatory defect and the cavity was impacted, reamed and cup was placed with or without cementation femoral stem revisions did not required any bone grafts.

In calcaneal fractures the articular, surface was elevated and the subchondral bone defect was packed with femoral head allografts.

In spine after anterior decompression the gap was treated with femoral ring allograft with cancellous autograft within the medullary canal of the allograft. Instrumentation was used in one case.

Allograft Retrieval and processing

Femoral heads were retrieved from patients undergoing total hip replacement or hemiarthroplasty for fracture neck femur, osteoarthritis, degenerative or post traumatic arthritis. Lower end of femur or upper end tibia with retrieved from patients undergoing total knee arthroplasty were also used as a source of allograft bone.

After informed consent graft was harvested under aseptic condition. Samples from bone graft were sent for bacteriological and histopathological examination. Bone was thoroughly washed by pulsatile lavage system to remove blood and cellular elements. They were removed of all soft tissues, articular cartilage, and morsellized and then the pulse lavage was applied. The femoral Head was then washed with aqueous betadine for 5-10 min, again washed with saline, wiped, dry packed in sterile container or a double sterile plastic or latex packed and aseptically sealed and the graft was labeled and stored in deep freezer at -80°C. The blood of donor was screened for HIV 1, 2, HBV, HCV and VDRL and again after 3 months. Only when serology is negative graft was used.

Informed written consent was sought and obtained from every patient prior to use of bone allograft.

All the Heads were treated with moderate Heat treatment (or) flash autoclaving prior to use.

Cortical strut allografts were procured from Sri Lankan bone bank from time to time and were used.

Similar post operative antibiotic protocol was followed for all patients. Antibiotic prophylaxis with IV cefotaxime (1 gm to 2 Gms IV TDS) for 2 weeks and oral antibiotic for another 4 weeks were given.

Post operative protocol was tailored for each patient depending on their lesion, surgery. Allograft (cortical or cancellous) used, fixation if any and special axes like spine, calcaneum.

Clinical data and follow-up

All the benign tumor patients were followed up every month for first 3 months, then after every 3 months for 1 year, every 6 months for the 2^{nd} year and then yearly.

Calcaneal fracture cases, nonunions, revision Hips and Caries spine cases were also followed in the same manner as for the tumor up to the period of incorporation and every 6 months to one year there after.

All the cases were analyzed based on the ENNEKINGS Scoring System for functional outcome. In addition the spine cases were analyzed with Bridwell radiological grading, fracture calcaneum with Paul et al subjective scoring and revision hips with Harris hip score. The Bony union was analyzed by Radiological methods, comparing with the preoperative and serial post operative pictures (x-rays).

Radiological review

Radiological assessment for union was complete for almost all patients. AP and lateral views of the affected parts were taken and compared with the preoperative X-rays and those taken at previous review.

In case of revision hip radiological failure was defined as cup migration of more than 4mm, cement fracture, evidence of graft resorbtion, and presence of Radiolucencies at host graft interface and absence of trabecular bridging.

In spine cases by increase in the kyphotic angle, graft resorbtion / incorporation are taken into account.

OBSERVATION AND RESULTS

Demographic Data of study group

Between Feb 2003 – Oct 2006, 38 cases of cancellous femoral head cortical allografting were carried out for various trauma and orthopaedic conditions at the department of othropaedics, Madras Medical College and Govt. General Hospital. 22 of the patients were male and 16 patients were females, the mean age was 26.78 years with a range of 6 to 55 years.

TABLE - 1

AGE DISTRIBUTION OF PATIENTS

Age in Years	Males	Females
1 – 10	1	1
11 – 20	7	7
21 – 30	7	2
31 – 40	5	2
41 – 50	1	3
51 – 60	1	1
	22	16

TABLE - 2

SITE OF BENIGN BONE TUMORS

Proximal Humerus	6
Proximal Femur	4
Distal Femur	8
Proximal Tibia	1
Shaft of Femur	2
Shaft of tibia	1
Metatarsal	1
Metacarpal	2
Talus	1

Clinical data of Study Group

Among the 38 patients there were 21 (57.89%) benign bone tumor cases, 9 (21%) cases of traumatic non unions, 3 (7.89%) spine cases, 2 (5.26%) revision hips and 3 (7.89%) calcaneal fractures.

Benign bone tumors were classified based on musculoskeletal tumor society grading.

TABLE - 3

GRADE OF THE LESIONS TREATED

Grade	No. of Cases	Percentage
Grade I	11	52%
Grade II	7	30%
Grade III	3	14%

TABLE - 4

TRAUMA CASES

Diagnosis	No. of Cases	Percentage
Femoral Non union	6	50%
Tibial Non union	2	16%
Humerus Nonunion	1	8%
Calceneal fractures	3	25%

Other cases were 2 cases of revision hip arthroplasty of which one case had type III combined AAOS (1989) acetabular bone loss[50] of the other case had type I segmental (superior, position) bone loss.

TABLE - 5

ACETABULAR DEFECT AAOS[50]

Type of defect	No. of Hips
Type I Segmental defect	1
Type III combined defect	1

TABLE - 6

BENIGN BONE TUMORS

Type of Lesion	Primary	Recurrent	Total
Giant cell tumor	3	1	4
Aneunysmal bone cyst	2	-	2
Fibrous dysplasia	5	2	7
Chondroblastoma	2	-	2
Simple bone cyst	2	-	2
Chondromyxoid fibroma	1	-	1
Osteochondroma with Fracture	2	-	2
Chondroma	1	-	1
Total	18	3	21

Operative data

Among the 21 (57.89%) benign tumor cases extended curettage or marginal resection was done depending on the grade of the lesion the defect was reconstructed or filled with fibular strut allograft and or with cancellous femoral head graft alone.

TABLE - 7

SURGICAL TECHNIQUE ADOPTED

S.No.	Surgical Technique	No. of Cases
1.	Curettage or Extended curettage (Intra lesional treatment)	17 cases (82%)
2.	Marginal resection	4 cases (18%)

TABLE - 8

GRAFT USED

S.No.	Grafts	No. of cases
1.	Femoral Heads alone	15 (73%)
2.	Fibular strut grafts (autograft & allograft)	5 (23%)
3.	Tibial strut allograft	1 (4%)

In addition to cortical strut allografts, implants were used in few cases such as screws, Dynamic Hip Screw, Broad and narrow Dynamic Compression Plates and stainless steel wires.

Among the trauma cases 3 cases of femoral non unions were treated as for any non union and the cancellous femoral head allograft was packed at the fracture site. 3 cases of the Gap non unions were treated with tibial and femoral cortical strut graft, 8 cms in one case and 6 cm in one case and cancellous autografts and allografts were packed at the graft host junction. Cancellous allograft alone was used in one case. Tibial non unions were treated with plating and cancelluos bone grafting in one case and Interlocking nailing and cancellous grafting in one case. Humeral non union was treated with 'T' buttress plating and cancellous grafting.

TABLE - 9

DROR PALEY et al CLASSIFICATION

Type of Non union	No. of cases	Treatment
Type A1	3	Cancellous allografts alone
A2 -1	2	
A2 -2	-	
Type B1	4	Cortical strut grafts + cancellous allo and autografts (at graft host Jn)
B2	-	
B3	-	
Total cases	9	

Revision Hip arthroplasty

After removing the implants at the acetabular aspect, the defect was reconstructed with whole femoral head graft and fixed with cancellous screws and or kwires, reamed and the cup was seated without cementation in one case and with cement in one case.

Spine

2 cases of caries spine were treated with anterior decompression thro the lateral thoracotomy approach and after corpectomy and decompression the gap was maintained with femoral ring allograft with cancellous autografts anterior

instrumentation was used in one case and external plaster of paris support (Two table plaster cast) was used (for 3 months) in one case. Idiopathic scoliosis was treated with luque rod and sublaminar wires and posterolateral fusion with cancellous graft.

Calcaneal Fractures

These cases were treated through lateral approach under image intensifier the articular surface was elevated and the underlying bone defect was packed with cancellous femoral head graft and stabilized with K-wire, in one case, screws alone in one and with reconstruction plate in one case.

Clinical observation and results

Patients were followed up for an average of 12.5 months (Range 3 months – 27 months). 5 cases lost follow up. All the other cases had been followed up in detail and therefore their data was included in the study.

All patients were analysed based up on the Enneking scoring system[54] and by radiological evaluation. Revision hip arthroplasties of calcaneal fractures were analysed separately by AAOS Scoring System and Paul Scoring System for subjective criteria respectively and Bridwell criteria of for allograft incorporation in spine.

According to the Ennekings scoring system (Annex – 1) for the functional evaluation

Excellent result - ≥ 80% (≥ 24/30)

Good result - 60 – 79% (18/30 – 23/30)

Fair result – 40 – 59% (12/30 – 17/30)

Poor result - < 40% (< 12/30)

We have excellent results in 17 cases (45%) Good results in 9 (23.6%) cases, fair results in 6 (15.8%) cases of poor result in 1 case. The poor result was due to early post of infection and wound gaping for which we had to remove the graft for control of infection. This was termed as failure.

TABLE - 10

TUMOUR AND TRAUMA CASES

Lesion	**No. of Cases**	**Avg. Score at last follow up (30)**	**Percentage**
Benign bone tumors	21	22.6	75.3%
Trauma cases	12	21.6	72.2%
Spine	3	25.3	84.4%
Revision Hip arthroplasty	2	21.5	71.6%

TABLE - 11

AGE GROUP WISE RESULT

Age in years	No. of patients	Good to excellent result
1 - 10	2	1
11 – 20	14	10
21 – 30	9	4
31 – 40	7	7
41 – 50	4	2
51 – 60	2	2
	38	26

Revision hip arthroplasty cases were analysed based on the Harris hip score (Annex II). We had a post operative Harris hip score of 80 and 68 respectively in the two cases.

TABLE - 12

REVISION HIP ARTHROPLASTY - RESULT – HARRIS HIP SCORE

	Pre operative	Post operative	Improvement in Hip Score
Case I	21	80	59
Case II	18	68	48

Calcaneal fratures (3 cases) were analysed based on the Paul Scoring system for subjective criteria (PSSSC)[52] we have excellent outcome in one case (Case III) with Bohlers(BA) angles > 10°, early return to physical activity and work, without any pain and 63.4% result in 2 cases with Bohlers angle < 10° without pain or 2° arthritis in one case and minimal pain, change in shoe wear and difficulty in physical activity in one case (Case II).

TABLE - 13

CALCANEAL FRACTURE – PAUL SCORING SYSTEM FOR SUBJECTIVE CRITERIA

S. No.	Case	Pain	Return to work	Physical Activity	Change in shoe wear	Subtalar arthro-desis	B.A.	Score
1.	Case I	None	Yes	Yes	Yes	No	<10°	4/6
2.	Case II	Minimal	Yes	No	No	No	>10°	4/6
3.	Case III	None	Yes	Yes	No	No	>10°	6/6

Caries spine cases were analysed based on the criteria of Bridwell et al for radiological evaluation of allograft in corporation. Both the cases have only short term follow up of 3 months and difficult to comment on its outcome. But at this stage both show an intact graft, not fully remodeled and minimally incorporated and shows no lucency. Neurological recovery is shown in both the case.

Higher values of the final score and percentage of improvement in function were seen in patients in whom cortical grafts were used with or without morcellized allografts. This may be explained by the fact that the cortical grafts provide immediate stability in addition to the implants used.

TABLE - 14

MORSELLIZED GRAFT VS STRUCTURAL GRAFT

Group	Ennekings Score (Mean) (30)	Percentage (Mean)
Morsellized (n = 31)	22.33	74.445
Structural (n = 7)	23.57	78.56%

There was no statistically significant difference in the outcome in the usage of the bone autograft and allografts.

TABLE - 15

AUTOGRAFT VS ALLOGRAFT

Group	Ennekings Score (Mean) (30)	Percentage (Mean)
Autograft (n = 8)	21.71	72.36%
Allograft (n = 30)	22.64	75.46%

Final hip score was good or excellent in 26 cases (68.42%), fair result in 6 (15.78%) cases.

TABLE - 16

GRADING OF ENNEKINGS FUNCTIONAL EVALUATION SCORE

Group	No. of Patients	Percentage
Excellent ≥ 24	17	44.64%
Good (18 – 23)	9	23.62%
Fair (12 -17	6	15.78%
Poor < 12	1	2.6%

Radiological Observation and Results

Radiological data were available for 33 cases which came for follow-up. Graft resorbtion was noted in 2 cases of the 31 cases treated with cancellous allografts. All the cases were asymptomatic and are on a regular follow up. Among the 7 cases treated with cortical allograft no cases were associated with graft resorbtion. Loosening of the DCS implant was noted in one patient one case has extensive resorbtion of the graft completely which turned out to be a recurrence. Since the follow up is short in spine cases resorbtion or incorporation could not be assessed. Incorporation of the cortical grafts could not be assessed in terms of trabecular continuity between graft and host and needs further long-term follow up for analysis.

Complications

Infection is the most common complication seen in 5 (13.15%) cases. 1 case had deep infection in the immediate post op period which was due to wound gaping and the graft was completely removed. Other 4 cases had superficial infection treated by curettage of the sinus tract, culture and appropriate IV antibiotics.

2 cases (5%) developed partial resorbtion of the allograft one of which had resorbtion of the cortical graft with micro fracture treated conservatively. The other patient is a case of recurrent GCT distal femur treated with extended curettage and grafting came with asymptomatic resorbtion at two years follow-up. In both the patients it was pain free and the lesions were left such.

1 patient (2%) developed recurrence of the lesion, GCT proximal phalanx of ring finger; Ennekings Grade III Lesion which was treated by marginal excision has recurred and was treated by (4^{th}) Ray amputation.

1 patient (2%) developed pathological fracture at the graft host junction which was treated conservatively with groin to toe cast, healed well with good bridging callus.

TABLE - 17

COMPLICATION

Infection	No. of Patients
- Superficial	4
- Deep	1
Recurrence	1
Resorbtion	2
Pathological	4

DISCUSSION

The use of allograft bone dates back to early 1900s, the first long term follow-up evaluation showed that these grafts were partially replaced and incorporated by the host and that joints could be preserved for as long as 20 years after surgery[37].

Bone grafting is one of the most frequent operations performed. Autografts remain the gold standard as they are osteoconductive as well as osteoinductive and have osteogenic cells.

But when the graft requirement is larger as in massive defects or in children or where the autograft availability is small and harvesting can damage the open growth plates, the role of allografts comes into play.

There are variety of options for treating these bone deficiencies such as autografts, the cancellous and cortical allografts in various orthopaedic conditions, such as benign bone tumors, non unions calcaneal fracture, revision hip arthroplasties and spine. Autografts, bone substitutes, demineralized bone matrix and allografts.

Though autografts are the best, its availability and donor site morbidity limits their use. Bone substitutes such as calcium hydroxy apatite are studied extensively; they are osteoconductive to an extent and partly are not incorporated for long run. Bone morphogenic proteins are osteoinductive only.

In our study we have evaluated the clinical and radiological outcome of the allografts in terms of Ennekings functional evaluation score[54] for all cases, Harris hip score in revision hip, Bridwell et al criteria for spinal allografts and Paul scoring system for subject criteria (PSSSC)[52] for calcaneal fractures.

The allografts have several advantages when used alone on in combination with autografts. They are available in large quantities, optimal enhancement of bone formation, requires a minimal threshold quantities of cancellous bone. Under filling cortical bone defects delay bone formation, while there appear to be no harm in over filling cortical bone defects. It can be used in patients who are poor operative risks or when patients choose it to avoid pain and morbidity. One study[60] noted that autograft in comparison with demineralized bone matrix allograft, resulted in a longer operative time, subsequently greater blood loss, and over all higher cost to patients associated with autograft collection[55,56].

Allografts provide the form and matrix of bone tissue, but no viable cells are transplanted. In addition, bone allografts are more slowly incorporated into the host and induce on immune response, which may delay the osteoinductive phase of bone graft incorporation[57,58,59]. Although structural allografts are widely used, it is not without problems. We have autoclaved the grafts so as to denature the proteins and thereby reduce immunogenicity and reduce the risk of infection.

Concerns with allograft use

Studies have shown that freezing of cortical and cancellous grafts may improve their incorporation[57] we routinely freezed the femoral head allografts after processing. The cortical allografts used were irradiated fresh frozen grafts only.

Overt graft rejection is extremely rare, and clinical studies have not shown adverse effects secondary to the immunogenicity of allografts[61,62,63] Allografts is weakest during revascularization, and the mechanical property of the bone graft may be affected by preservation techniques. The freeze – dried allografts is weaker in its torsional and bending strength as well as the autoclaved allografts. Whereas, when compared the frozen allografts have better torsional and bending strength. The compressive strengths of these grafts are equivalent. Loss of hoop stress and cracking of the allograft has been observed after surface drying [62,64,65,66]. These factors, however may not apply to the small size of the grafts such as the cancellous femoral head allografts used in this study (31 cases, 81%) and no fracture of a graft was noted during the period of study in these patients who were studied, except for one case who had micro fracture and another case who had stress fracture at the cortical graft – host junction which has nothing to do with the graft per se.

Another concern with the use of structural allografts is the possible transmission of infection. Although extremely rare, transmission of disease is possible. An audit from bone bank in Leicester, England[67] showed contamination femoral head grafts from both live and cadaveric donors and one clinical infection was documented in the nine large allografts implant[68].

To negate the possibility of the infection (pyogenic as well as other viral diseases we had routinely flash autoclaved (at 121°C for 10 min) fresh frozen allografts in addition the donor screening procedures that is done routinely in any bone banks. This has shown to contribute to improving safety in human transplantation even though they have adverse effects on incorporation which is not much disturbed in our study of cancellous allografts.

Conventionally, bone allografts are ordered depending on intra operative findings in the form of number of femoral heads. But Henman and Finalyson[69] stated that this approach results in great variability in size and density of femoral heads. This variability may compromise the stability of the impacted graft and recommended requesting allograft by weight not quantity which predicts more accurately the volume of graft after impaction.

In our study we have used Ennekings scoring system for the functional evaluation and the clinical outcome of surgery. The mean Ennekings score at an average follow up of 12.5 months was 21.82 points (72.71%). In our study among benign bone tumor GCT and fibrous dysplasia toped our list with seven cases each and distal femur was the commonest site as compared to international studies. Excellent results were seen with grade I lesion as compared to grade II & III lesions.

Jaffe et al. (2003)[42] has treated fifteen patients with benign lesion of the proximal femur by intraletional curettage and fibular cortical allograft strut in conjunction with sliding Hip screw. Clinical results were excellent in all these patients. Radiographic assessment of the patients showed no evidence of recorded tumor, fracture or graft resorption at the most recent follow up.

Lobo Gajiwala and Agarwal (2003)[43] has treated 41 cases of Benign bone tumors with indigenously procured, lyophilized irradiated bone allografts. Of the 25 cases available for follow – up complete incorporation of graft was seen in 21 cases. Excellent or good results were shown in 16 cases. 3 cases had deep infection.

Comparisons of the results are shown in the table 18.

TABLE – 18

COMPARISONS WITH OTHER STUDIES

	Jaffe et al 2003	**Lobo Gajiwala and Agarwal 2003**	**Our study**
Total Cases	15	41 (Available cases – 25)	22 (Lost Followup-3)
Cases included	Proximal femoral lesions	Benign tumors from various sites	Benign tumors from various sites
Grafts used	Cancellous and cortical strut grafts	Allografts with Cancellous autografts / marrow	Cancellous ± cortical strut grafts
Implants used	All cases	Selected cases	7 cases
Complications	Nil	Sterile drainage - 5 Deep infection – 3	Superficial infection – 2 Recurrence – 1 Graft resorbtion – 1 Pathological fracture - 1
Results (Ennekings functional score)	Excellent - 15 cases	E or good – 16 Fair – 5 Poor – 3	E – 10 cases G – 5 F - 4

In our study good to excellent results were high in those in the age group of 11 -20 years (71.42%) and 31 -40 years (87.5%) the difference may be due to higher number of cases in this group and the disease process involved in them. This could also be due to shorter follow up in the patients.

Lin-Hsiu Weng et al (2004)45 has treated 18 patients of femoral nonunions with internal fixation, cortical strut allografts and cancellous autografts. All 18 nonunion healed on an average period of 8 months, no significant complications were encountered except for screw irritation and graft protrusion.

In our study of 9 cases, 7 came for follow up, of which we have good or excellent results in 6 cases. All six cases healed on an average period of 7.6 months. One case had deep infection for which the graft was removed completely.

Comparisons of the studies are shown in the table19.

COMPARISON WITH OTHER STUDY

	Lin-Hsiu Weng et al (2004)	**Our study**
No. of cases	18	9(available – 7)
Cases included	Femoral nonunions	Femoral nonunions Tibial nonunoins Humeral nonunions
Graft used	Cortical strut allograft Cancellous autograft	Cortical strut allograft Cancellous auto and allograft
Average time of union	8 months	7.6 months
Result (radiological union)	Good or excellent result - 18 cases	Good or excellent – 6 Poor - 1

Among the cases of the non unions the patients in Paleys type A1 (Mobile non union) showed better results the (76.67%) when compared to the type B1 (Gap >1cm without deformity)

(51.67%) this may be due to the fact that better impaction could be achieved in the fracture ends in cases of mobile non union as compared to stiff non union (A2- 1) or non union with bone gap (B1). The fair results in the type B1 (Dror Paleys)[51] is also due to the preoperative knee stiffness they had and the time delay after the index surgery was performed were too long.

Mean preoperative Harris hip score observed was 19.5 points in the two cases, which improved to a mean, post operative Harris hip score of 74 points. The mean improvement in the Harris hip score was 53.5 points. This result was after an average follow up of 8.5 months. Similar results were reported by Jastly et al (1987)[70] Avci et al (1998)[71]. They reported mean postoperative Harris hip score of 85 and 82.5 points at the end of follow up respectively. Eggr et al [72] reported an average clinical improvement of 40.1 points (as compared to 53.5 points in our study) according to Harris hip score.

Among the spine cases, posterolateral fusion done for the scoliosis had fused completely by six months time. The two cases of caries spine for which anterior decompression done, had excellent result radiological with Grade II Bridwell et al criteria[44] there was no post operative kyphosis or collapse of the graft at the last follow up. One case showed partial incorporation and the in other case signs of incorporation are yet to come. But the functional outcome was excellent in both the cases and both had good neurological recovery at the last follow up. Through the results cannot be generalized with three cases for a short follow up, ring allografts provides an excellent alternative for the rib grafts or tricortical grafts and cases for single level stabilization. Govender et al 2002[44] had shown that fresh frozen allografts and anterior instrumentation are superior to rib grafts for carries spice and although the incorporation of the allograft was delayed, the graft remained stable. There were no cases of sepsis in our series, and neurological recovery is present in one case and the same neurological states remained in the other case. There was a dramatic improvement in pain in both the cases.

The calcaneal fractures were assessed by the Paul et al scoring system for subjective criteria (PSSSC)[51]. All the patients returned to work post operatively, though one patient had minimal pain at the last follow up. One patient have Bohlers angle (BA) < 10° but she had no pain, and required a change of shoe wear. No patients developed subtalar arthritis at the last follow up and did not required subtalar arthrodesis the results were comparable to the study of Paul et al (2004)[51]

Higher post operative Enneking score was obtained in patients in whom cancellous and cortical allograft were used (75.46%) when compared to the autografts (72. 26%) this difference was not statically significant and both the autografts and allografts does not have significant difference in the clinical outcome of these patients. But radiologically autograft showed a definite edge over the allografts in their early incorporation and remodeling.

Higher postoperative Ennekings score was observed in patients in whom structural allografts (78.56%) were used as compared to cancellous grafts (74.44%). This might be explained by the fact that the structural allografts had achieved immediate stability in addition to implants and were used along with cancellous autografts for osteoinduction at the graft host junction. But radiologically the cancellous allografts showed an early incorporation in most of the cases and the strut allografts showed delayed incorporation except at the graft Host Junction due to autografts.

Implants don’t seem to alter the post operative outcome in all these patients. Implants might act as a nidus for infection and may increase the risk of infection. But we did not have any implant related infection in our series.

Radiologically resorbtion (or) non progressive radiolucency were noted in 3 cases (7.8%). Resorbtion of allograft was noted in 2 cases (5.2%). Graft appeared to be incorporated in 24 cases (62.86%) almost completely, (15.78%) cases showed delayed or partial incorporation and 3 cases (7.89%) showed no incorporation radiologically. Higher rates of incorporation were seen with cancellous allografts when compared to cortical start allografts.

Radiological failure rate as high as 18% and 30% have been previously reported in literature by Jasty et al (1987)[70] and Pollock and Whitside 1992[73].

Our study had 23.68% radiological failure rate and is comparable to the studies of Jasty et al and Pollock and Whitside et al.

Only one patient in our study required re-surgery so far due to recurrence of the tumor (GCT) during the follow up period (3 months following the index procedure).

We had superficial postoperative infections in 4 cases (10.56%) which were treated with swab culture and sensitivity and appropriate antibiotics curettage of the sinus tracts in two cases.

Two of the patients lost follow-up, after curettage one patients developed deep infection at 10 months follow-up was treated with antibiotics, he showed good incorporation of the graft at the bone gap site but the patient was not willing for implant exit and debriedment.

One patient (2%) developed deep infection in the immediate post operative period with wound gape and was treated with immediate curettage and removal of the graft.

One patient (2%) developed recurrence of the tumor (GCT) in the base of the proximal phalanx of ring finger for which Ray amputation was done. She is disease free at the last follow up.

We had one case of pathological (stress) fracture (2%) at the graft host junction in a case of exostosis femur which was treated conservatively with groin to toe cast and showed good bridging callus.

None of the patients developed systemic infection this highlights the fact that a through donor screening, proper allograft processing and storage was as essential as operative planning and technique for successful outcome of the procedure.

Although the short term results were encouraging, it is required to study these cases for longer periods to reach a conclusion about the state of incorporation of structural bone allografts and need for re – surgery at a longer follow up.

CONCLUSION

1. Bone allograft is a safe and reliable adjuvant in the management of bone defect in the setting of tumors and traumatic bone loss, and revision hip surgeries and spine surgeries.
2. Better results are observed with use of both morsellized and structural bone allografts clinically as well as radiologically.
3. Allograft procured and processed in sterile condition and stringent donor screening are very important safe guards for prevention of disease transmission.
4. Autoclaving though weakens the graft, reduces the immunological as well as reduces further, the risk of disease transmission without much comparative on bony union.
5. Cancellous femoral heads are an excellent method in the management of bone tumor defects.
6. Femoral head allografts are available options in traumatic bone defects and in children.
7. Cortical allografts and autografts add additional sterility to the defect.
8. The clinical results are good and support recommendations for continued use the grafts and development of the technique.

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ANNEXTURE – 1

ENNEKING SOCRIN SYSTEM

Criteria for either extremity

Pain: The value for pain is determined by the amount and effect of pain on the patients function.

The required information is the medication or equivalent measures currently by the patient for pain relief.

No.	Description	Data
5	No Pain	No medication
4	Intermidiate	
3	Modest / Non disabling	Non – Narcotic analygesics
2	Intermediate	
1	Moderate / Intermittently disabling	Intermittent narcotics
0	Severe / continuously disabling	Continuous narcotics

Function: The value for function is determined by the restrictions in activation (actual or prohibited and the effect of these restrictions on the patients lifestyle. The required data are the pretreatment occupation and the degree of occupational disability caused by the restriction(s).

No	Description	Data
5	No restriction	No disability
4	Intermediate	
3	Recreational Restriction	Minor disability
2	Intermediate	
1	Partial Occupational Restriction	Major disability
0	Total Occupational Restriction	Complete disability

Emotional Acceptance: The value for emotional acceptance is determined by the patients emotional reaction to or perception of the function result.

No	Description	Data
5	Enthused	Would recommend to others
4	Intermediate	
3	Satisfied	Would do again
2	Intermediate	
1	Accepts	Would repeat
0	Dislikes	Would not repeat

CRITERIA SPECIFIC TO THE LOWER EXTREMITY

Supports: The value for supports is determined by the type and frequency of external supports to compensate for weakness or instability as they affect standing and / or walking. The required data are the type of support and the frequency of use (i.e., none, occasional, mostly, always, etc.) it the patients is an amputee and uses a prosthetic limb, the type of prosthesis and frequency of its use as well as the type and use of external supports were recorded. Additional data on instability and strength may be entered here is desired.

No	Description	Data
5	None	No supports
4	Intermediate	Occasional use
3	Brace	Mostly brace
2	Intermidiate	Occasional cane/ crutch
1	One cane or crutch	Mostly cane / crutch
0	Two canes or crutches	Always canes/ crutches

Walking ability: The value for walking ability is determined by the limitation on walking imposed by the procedure. If limitations are imposed by other considerations (cardiac, respiratory, neurological) do not consider these. The required data are the maximal walking distance and limitations in type (inside/ outside, uphill, stairs, etc.,). Other pertinent data related to walking ability (i.e., oxygen consumption) may be entered here if desired.

No.	Description	Data
5	Unlimited	Same as preoperative
4	Intermediate	
3	Limited	Significantly less
2	Intermediate	
1	Inside only	Cannot walk outside
0	Not independently	Can walk only with assistance or wheelchair bound

Gait: The value for gait is determined by the presence or absence of gait alternation and the effect of these alternations on restrictions or function. The required data are the type of gait abnormality and resultant restriction or deformity. Pertinent data from gait analysis, joint motion., and deformation may be entered if desired.

No.	Description	Data
5	Normal	No alteration
4	Intermediate	
3	Minor cosmetic	Cosmetic alternation only
2	Intermediate	
1	Major cosmetic	Major functional deficit
0	Major handicap	Major functional deficit

Criteria specific to the upper extremity

Hand positioning: The value for hand positioning reflects the patients ability to actively position the hand of reconstructed extremity in space for functional activities. Passive or assisted positioning is not considered. The required data are the degree to which the hand can be elevated in the frontal plane and restrictions in pronation / supination. Additional pertinent data concerning range of motion of involved joints. Stability, and deformity may be entered if desired.

No	Description	Data
5	Unlimited	180 °
4	Intermediate	
3	Not above shoulder or no pronation supination	90 ° elevation
2	Intermediate	
1	Not above waist	30° elevation
0	None	0 ° elevation

Manual dexterity: The value for manual dexterity is determined by the patients ability to perform increasingly complex functions with the hand. Pinch and grasp can be performed in any fashion. Fine movements are those used in buttoning, writing, eating etc. The required data are limitations in dexterity and / or sensory loss in the hand.

No	Description	Data
5	Normal load	Matches normal
4	Intermediate	Less than normal
3	Limited	Minor load
2	Intermediate	Gravity only
1	Helping only	Cannot overcome
0	Cannot help	Cannot move

PROFORMA

Name:	**Age/ Sex**	**IP No.**
Hospital:	**Unit:**	**Ward:**
Address :		
Phone No:	**Date of Admission:**	
	Date of Surgery:	

Diagnosis:

Procedure:

Clinical Features:

O/E

Investigations:

X-ray

CT Scan/ MRI

Treatment

Type of Allograft Used

Method of Sterilization

Thawing

Antibiotic protocol

Follow Up

CASE 1

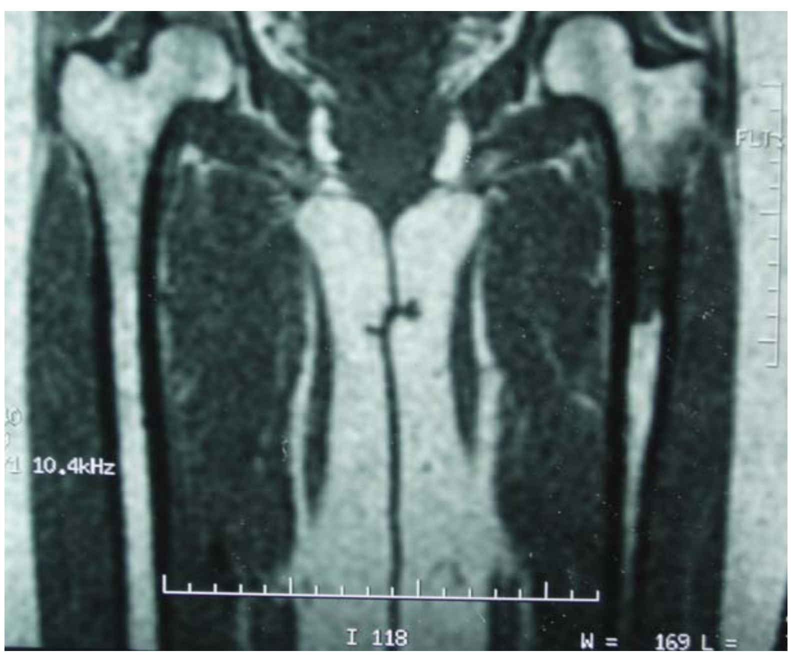
ANJALI 46/F

DIAGNOSIS : FIBROUS DYSPLASIA LEFT FEMUR

TREATMENT : CURETTAGE AND FEMORAL HEAD ALLOGRAFTING

PRE OP

MRI PICTURE



1 MONTH FOLLOW UP

27 MONTHS FOLOW UP

CASE 2

NARAYANAN 14/M

DIAGNOSIS : RECURRENT FIBROUS DYSPLASIA RT PROXIMAL FEMUR

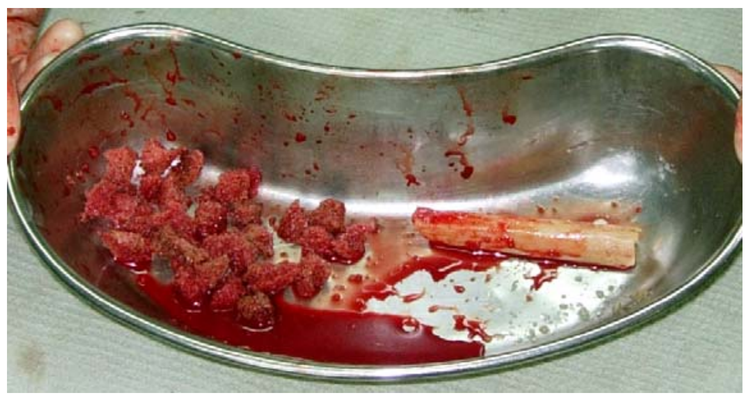
PROCEDURE : CURETTAGE FIBULAR CORTICAL AND FEMORAL HEAD ALLOGRAFTING

PRE OP

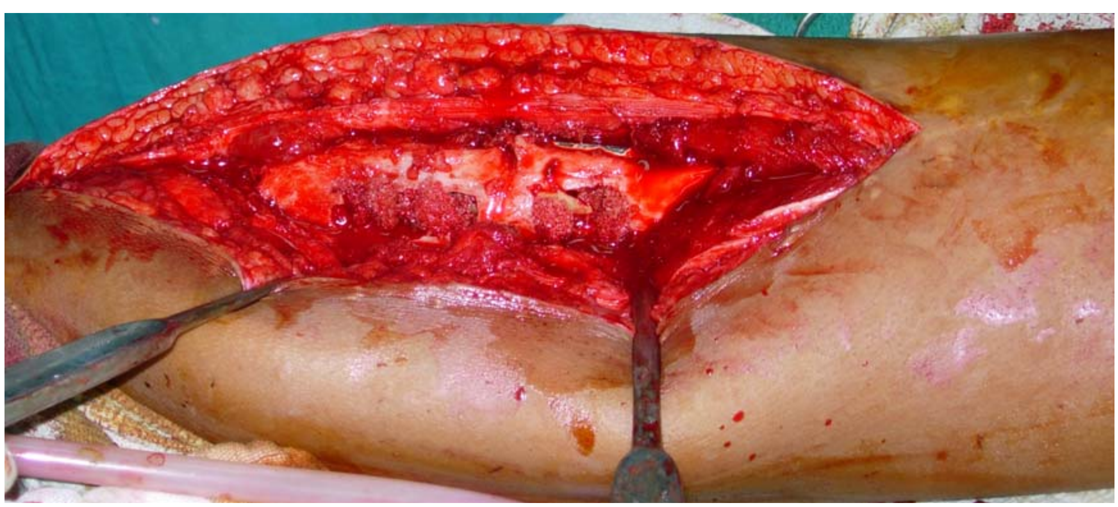
FIBULAR

ALLOGRAFT

CANCELLOUS GRAFT



PER – OPERATIVE PICTURE SHOWING THE CHART



IMMEDIATE POST OP

4 MONTH FOLLOW UP

8 MONTHS FOLLOW UP

CASE - 3

SARAVANAN 6/M

DIAGNOSIS : FIBROUS DYSPLASIA LEFT TIBIA

TREATMENT : RESECTION AND RECONSTRUCTION

WITH FIBULAR ALLOGRAFT

PRE OP PICTURE AP

LATERAL

IMMEDIATE POST OP PICTURE

2 YEARS FOLLOW UP

CLINICAL PICTURE AT 2 YEARS FOLLOW UP

PT. WEIGHT BEARING

CASE - 4

ARUMUGAM 30/M

DIAGNOSIS	:	GAP NON UNION SUPRACONDYLAR FRACTURE FEMUR
TREATMENT	:	TIBIAL CORTICAL ALLOGRAFTING AND CANCELLOUS ALLOGRAFTING

PRE OP AP AND LATERAL VIEW

IMMEDICATE POST OP

21 MONTHS FOLLOW UP

CLINICAL PICTURE

CASE - 5

RAMALINGA JOTHI 31/M 709909

DIAGNOSIS	:	MIGRATED ACETABULAR SHELL RIGHT HIP
TREATMENT	:	ACETABULAR RECONSTRUCTION WITH FEMORAL HEAD ALLOGRAFT AND REVISION

PRE OP - PICTURE

IMMEDIATE POST OP SHOWING GRAFT

15 MONTHS FOLLOW UP XRAY

CASE - 6

CHANDRAN 55/M

DIAGNOSIS : CARIES SPINE D9-D10 WITH PARAPARESIS

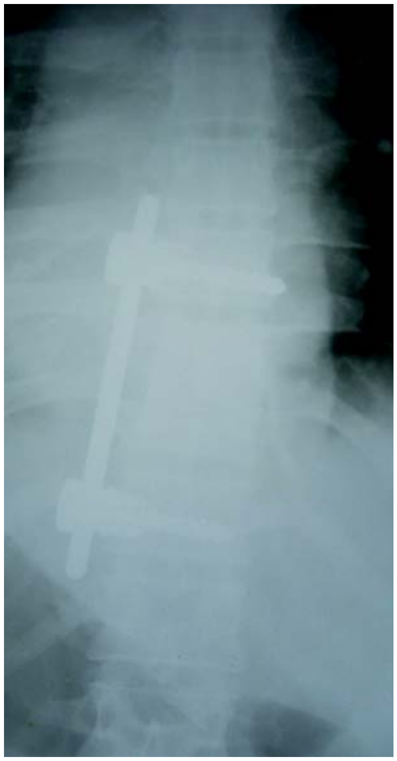
PROCEDURE : ANTERIOR DECOMPRESSION, FEMORAL RING ALLOGRAFTING AND INSTRUMENTATION

CARIES SPINE PARADISCAL VARETY

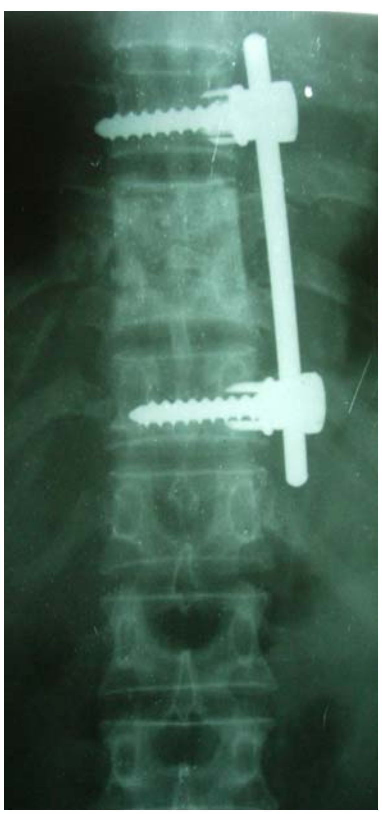
MRI PICTURE

MR MYELOGRAM

IMMEDIATE POST OP PICTURE



4 MONTHS FOLLOW UP



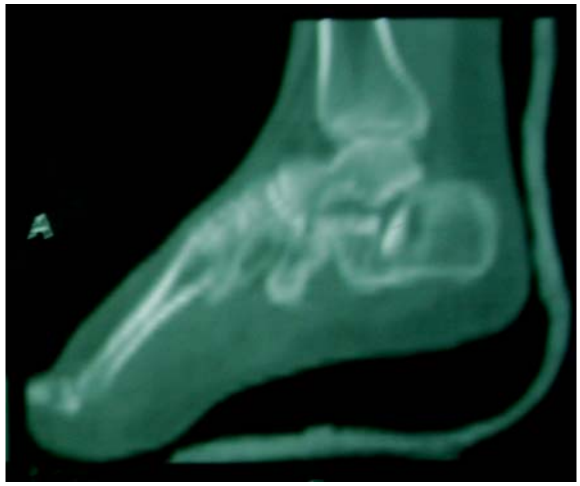
CASE - 7

UMA SHANKARI 38/F

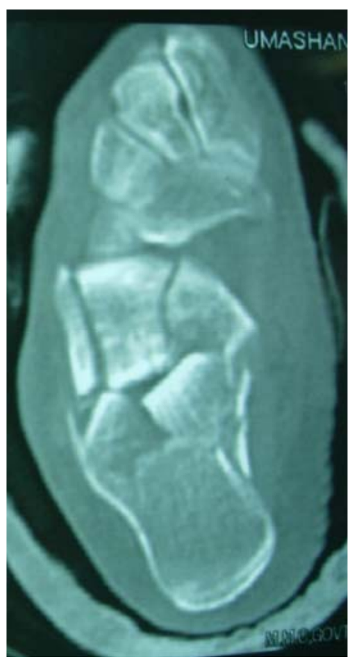
DIAGNOSIS : FRACTURE CALCANEUM RIGHT

PROCEDURE : OR IF WITH RECON PLATE AND
CANCELLOUS ALLOGRAFTING

PRE OP LATERAL VIEW (3D CT)



CT – CORONAL CUT SECTION



INTRA OP – SHOWING THE BONE DEFECT

AFTER PACKING THE CANCELLOUS ALLOGRAFT

IMMEDIATE POST OP XRAY

4 MONTHS FOLLOW UP– CLINICAL PICTURE

4 MONTH FOLLOW UP - XRAY

COMPLICATION

1. INFECTION

PRE OP

POST OP

2 MONTSH FOLLOW UP WITH DISCHARGING SINUS

2. PATHOLOGICAL FRACTURE

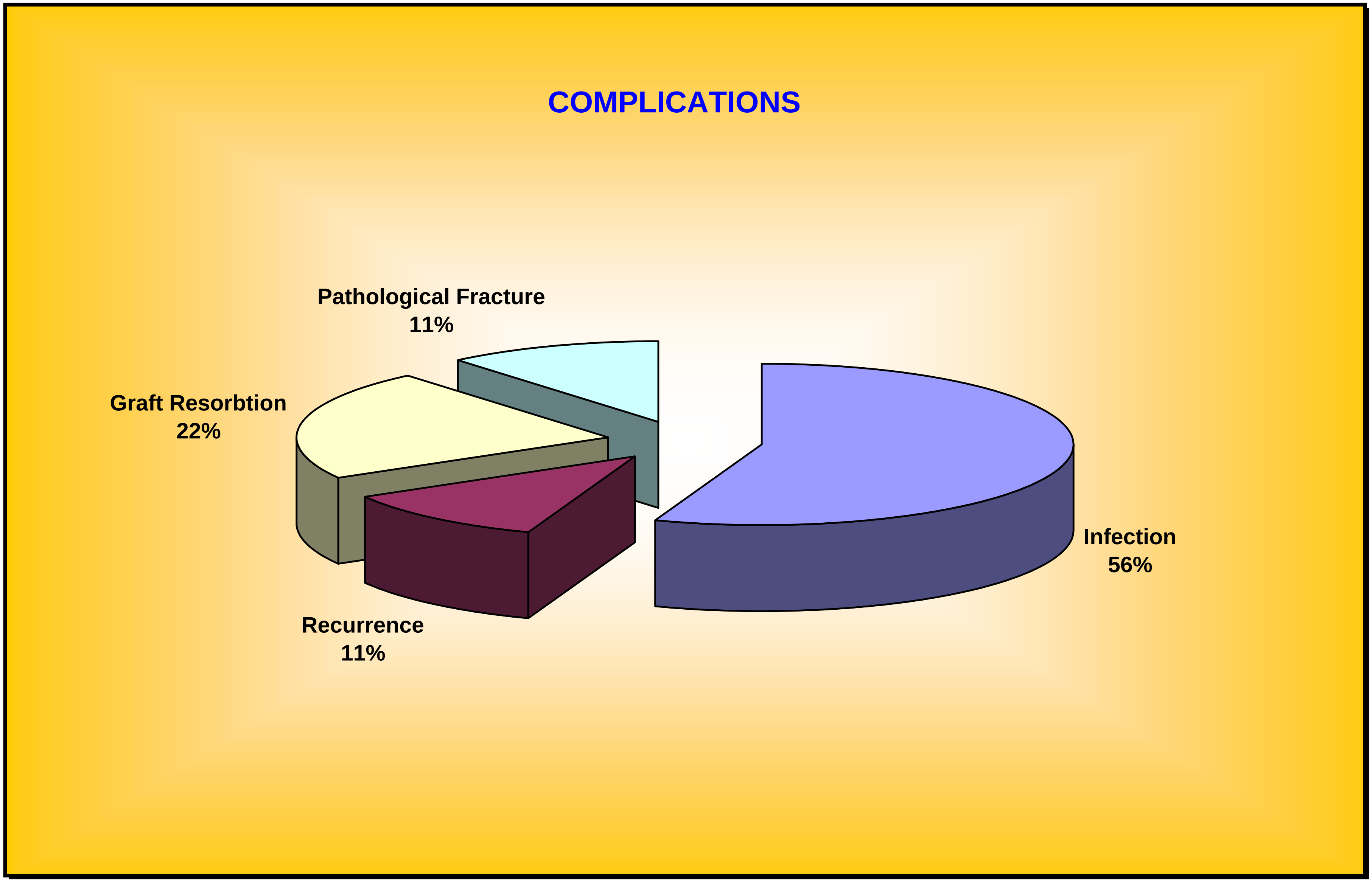
EXOSTOSIS DISTAL FEMUR **AFTER MARGINAL RESECTION**

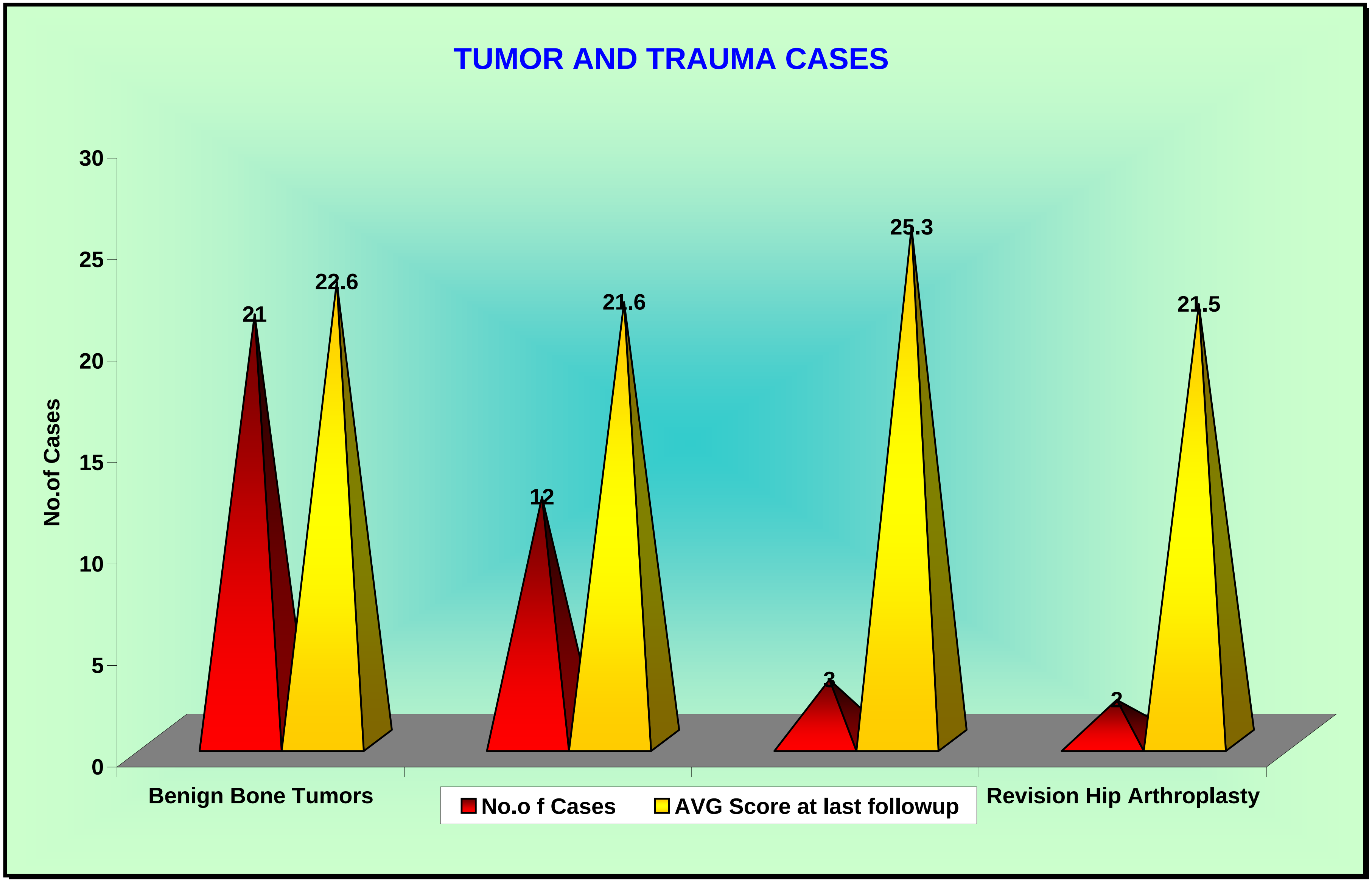
PATHOLOGICAL FRACTURE AT 2 WKS. **AT 3 MONTHS FOLLOW UP**

3. GRAFT RESORBTION

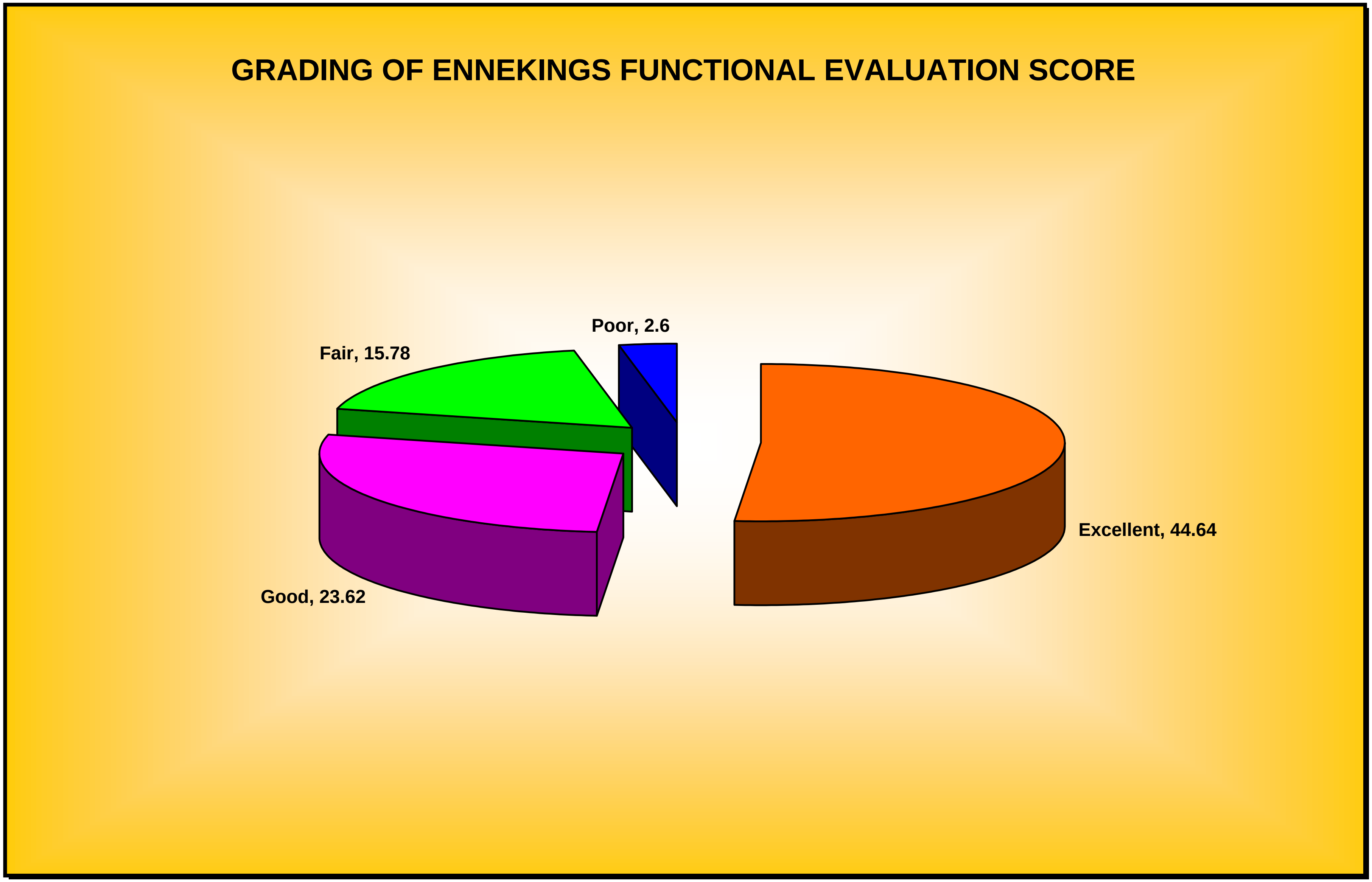
1 YEAR FOLLOW UP

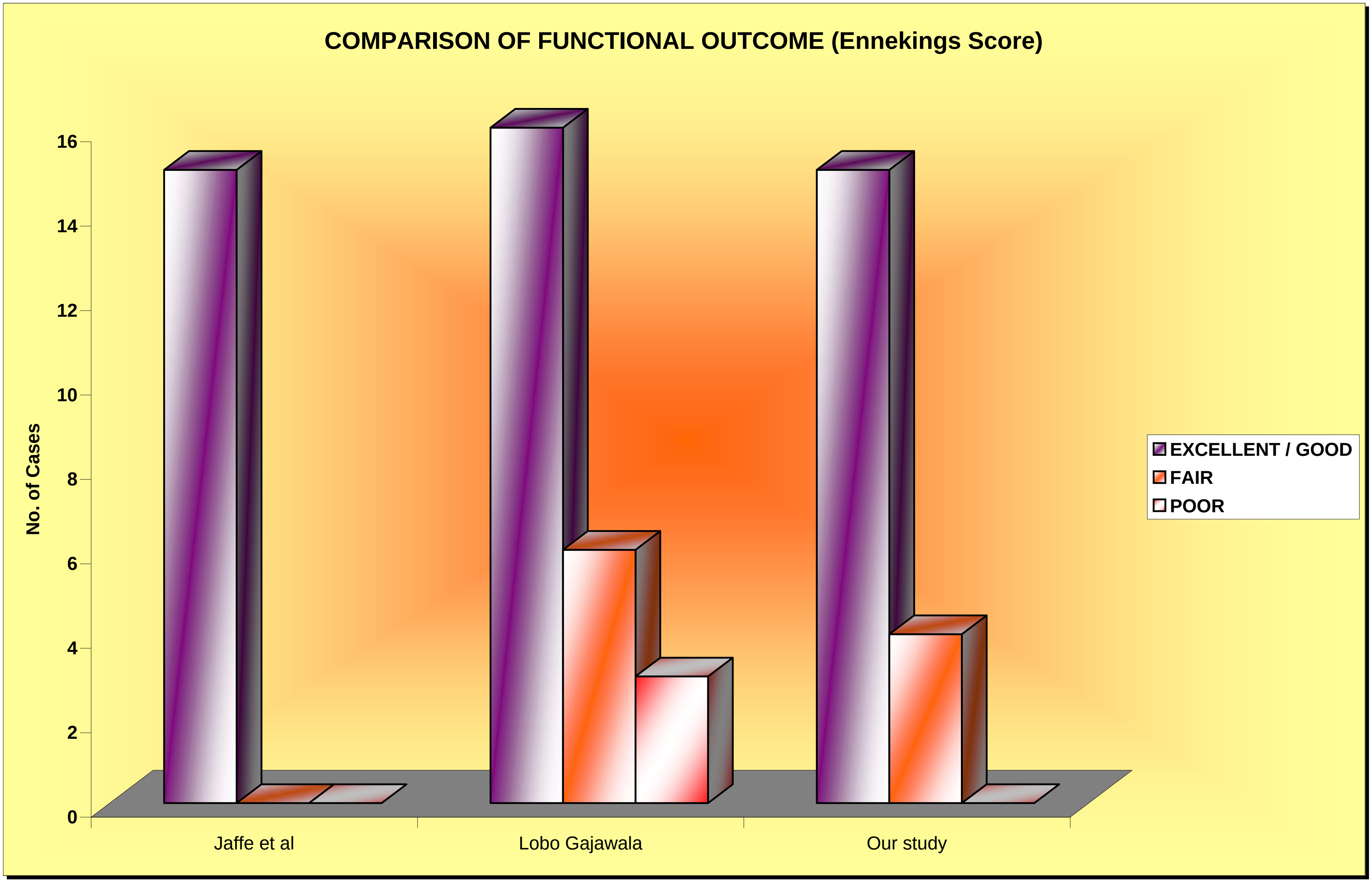
2 YEAR FOLLOW UP WITH GRAFT RESORBTION

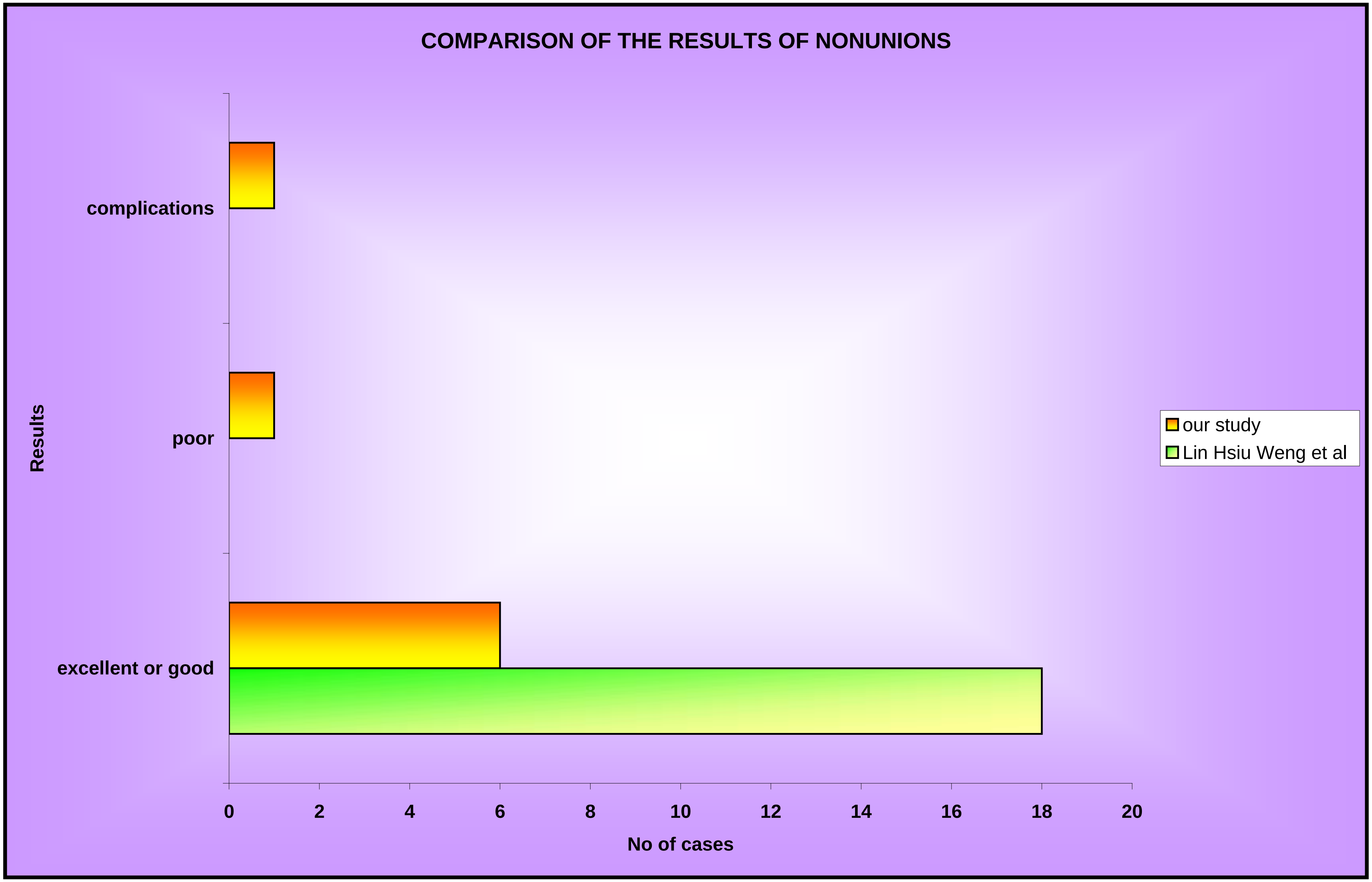

COMPLICATIONS
Pathological Fracture
11%
Graft Resorbtion
22%
Infection
56%
Recurrence
11%

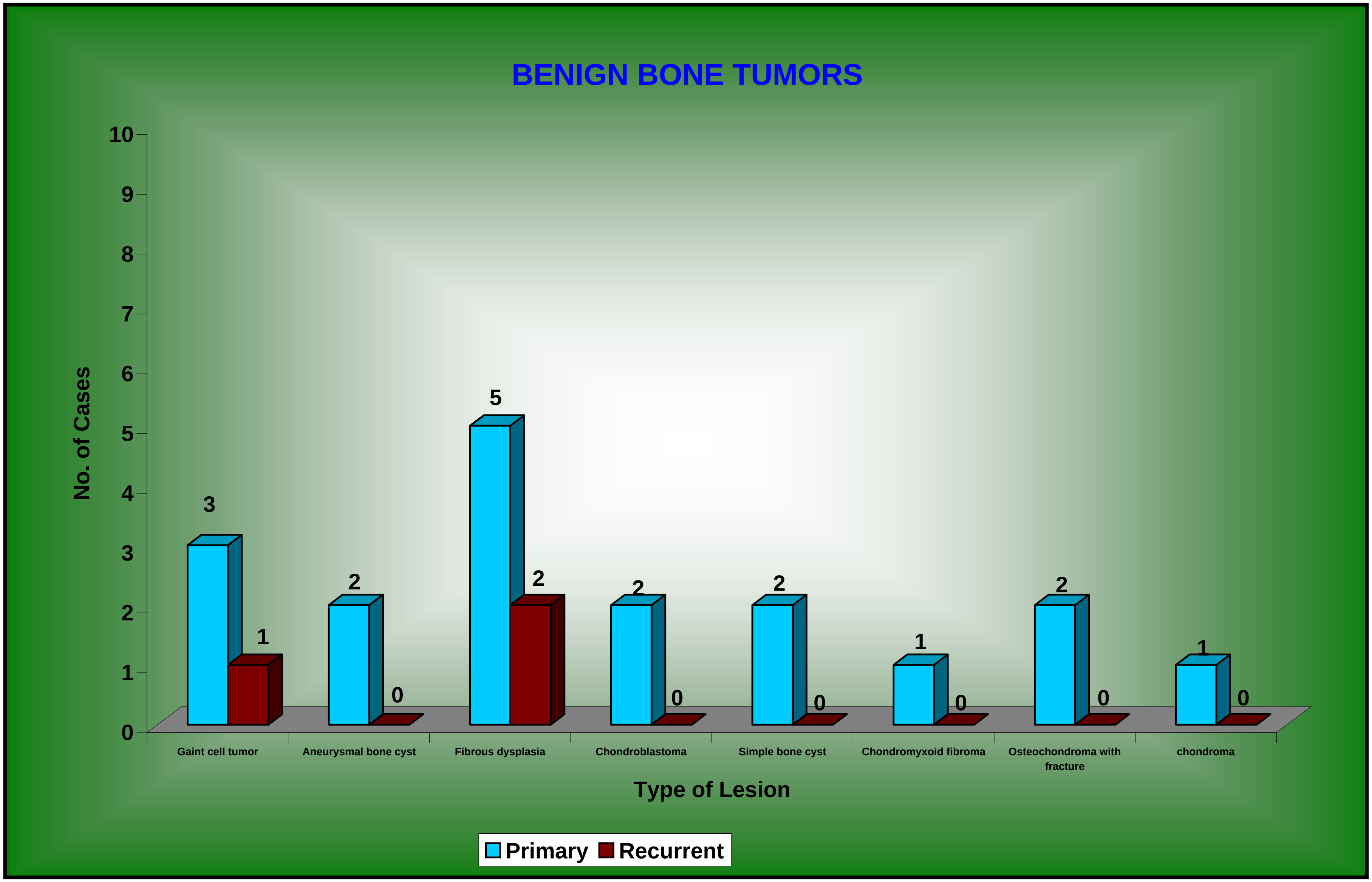


TUMOR AND TRAUMA CASES
No.of Cases
30
25
20
15
10
5
0
21
22.6
12
21.6
3
25.3
2
21.5
Benign Bone Tumors
Revision Hip Arthroplasty
No.o f Cases
AVG Score at last followup


GRADING OF ENNEKINGS FUNCTIONAL EVALUATION SCORE
Poor, 2.6
Fair, 15.78
Excellent, 44.64
Good, 23.62


COMPARISON OF FUNCTIONAL OUTCOME (Ennekings Score)
No. of Cases
0
2
4
6
8
10
12
14
16
Jaffe et al
Lobo Gajawala
Our study
EXCELLENT / GOOD
FAIR
POOR


COMPARISON OF THE RESULTS OF NONUNIONS
Results
complications
poor
excellent or good
0
2
4
6
8
10
12
14
16
18
20
No of cases
our study
Lin Hsiu Weng et al


BENIGN BONE TUMORS
No. of Cases
0
1
2
3
4
5
6
7
8
9
10
3
1
2
0
5
2
2
0
2
0
1
0
2
0
1
0
Gaint cell tumor
Aneurysmal bone cyst
Fibrous dysplasia
Chondroblastoma
Simple bone cyst
Chondromyxoid fibroma
Osteochondroma with fracture
chondroma
Type of Lesion
Primary
Recurrent

MASTER CHART

S.No.	Name	Age/Sex	Diagnosis	Duration of illness	Site of lesion	Type of lesion	CT/MRI	FNAC/ Biopsy	Prior Surgery	D.O.S.	Graft used			Implants	Compli cations	Failure	Follow up(months)	Enneking Score (30)	Harriship/Bridwell Score	Result	Graft Resorbtion	
											Fem. Head	Cortical Allograft	Autograft									
1	Madhu	12/M	SBC	6	PH	E. grade I	N	Y	N	29.09.03	Y	N	N	N	-	-	10	27	-	excellent	N	
2	Ravi	20/M	POFD	4	PH	E. grade II	N	Y	N	19.01.04	Y	Y	N	N	-	-	LF					
3	Muthu kumar	27/M	GCT	72	DF	E.grade I	N	Y	Y,1	05.03.04	Y	N	N	N	2	-	27	28		excellent	Y	
4	Kavitha	30/F	FD	7	PF	E.grade I	Y	Y	N	08.03.04	Y	N	N	N	1	-	6	17		fair	N	E.- ennekings score
5	Dhivya	10/F	CB	3	PT	E. grade I	Y	Y,2	N	07.05.04	Y	N	N	N	-	-	LF					P. - Paleys classification
6	Manju priya	15/F	cong.scoliosis	-	spine	-	N	-	N	17.05.06	Y	N	Y	Y	-	-	24	28	-	excellent	N	DF - distal femur
7	Prem kumar	13/M	SBC	24	PH	E. grade I	N	Y	N	20.04.04	Y	N	N	N	-	-	12	26	-	excellent	N	PH - proximal humerus
8	Anjali	46/F	FD	60	PF	E. grade I	Y	Y	N	06.08.04	Y	N	N	N	-	-	24	27	-	excellent	N	PF - proximal femur
9	Saravanan	16/M	FD	60	PH	E. grade II	N	Y	N	09.08.04	Y	N	N	N	1	-	6	16	-	fair	N	MET - metatarsal
10	Arumugam	30/M	gap nonunion	4	DF	P. type B1	N	-	Y,1	14.10.04	N	Y	Y	Y	-	-	21	15	-	fair	N	MEC - metacarpal
11	Saravanan	6/M	FD	12	left tibia m/3	E. grade II	N	Y	N	02.08.04	N	Y	N	Y	2	-	22	29	-	excellent	Y	
12	Ramalingajothi	31/M	failed THR	8	right HIP	AAOS type III	Y	-	Y,1	16.04.05	Y	N	N	Y	-	-	15	24	HHS 80	excellent	Y	SBC - simple bone cyst
13	Kamal	25/M	non union	7	left femur	P. type A1	N	-	Y,1	06.06.05	Y	N	N	N	-	-	11	24	-	excellent	N	FD - fibrous dysplasia
14	Muthammal	44/F	mal union	30	right femur m/3	-	-	-	-	07.06.05	Y	-	-	Y	-	-	LF					GCT - gaint cell tumor
15	Vijayakumar	26/M	gap nonunion	8	right DF	P. type B1	N	-	Y,2	10.06.05	Y	N	N	N	1	Y	-	-	-	poor	-	POFD - poly osteotic FD
16	Paulraj	18/M	ENC	36	MET II left	E. grade I	N	N	N	18.06.05	N	Y	N	Y	-	-	12	26	-	excellent		CB - chondroblastoma
17	Subani	37/M	GCT	4	DF	E. grade I	Y	N	N	19.10.05	Y	N	N	N	1	-	2	15	-	fair	N	ENC - Enchondroma
18	Narayanan	14/M	FD	75	PF left	E. grade I	N	Y	Y,1	05.12.05	Y	Y	N	Y	-	-	8	28	-	excellent	N	OC - osteochondroma
19	Narasiman	34/M	non union	6	right tibia	P. type A2-1	N	-	Y,2	14.12.05	Y	N	N	Y	1	-	8	21	-	good	N	ABC - aneurysmal bone cyst
20	Mani	42/M	gap nonunion	12	right tibia	P. type B1	N	-	Y,1	16.12.05	Y	N	Y	Y	-	-	LF					
21	Renuka	15/F	BIL # calcaneum	2 days	left calcaneum	-	Y	-	-	30.01.06	Y	N	N	Y	-	-	6	26	PSSSC 4/6	excellent	N	1 - infection
22	Masthan bee	16/F	FD	6	PF right	E. grade II	Y	N	N	24.02.06	Y	N	N	Y	-	-	LF					2 - resorbtion
23	Kabila	12/F	ABC	2	PH right	E. grade II	N	Y	N	17.03.06	Y	N	N	N	-	-	5	22	-	good	N	3 - recurrence
24	Raja	25/M	#calcaneum	1 day	Lt calcaneum	-	Y	-	N	03.04.06	Y	N	N	Y	-	-	5	25	PSSSC 4/6	excellent	N	4 - stress fracture
25	Venkatesan	21/M	OC	120	DF right	E. grade II	Y	Y	N	05.04.06	Y	Y	Y	Y	4	-	6	19	-	good	N	
26	Harish	16/M	CB	12	DF right	E. grade III	Y	Y	N	18.04.06	Y	N	Y	N	-	-	5	20	-	good	N	HHS - Harris Hip Score
27	Tamilarasi	20/f	ABC	2	talus left	E. grade III	Y	Y	N	22.04.06	Y	N	N	N	-	-	5	21	-	good	N	PSSSC - Paul Scoring System for Subjective Criteria
28	Raja	30/M	failed THR	20	right HIP	AAOS type I	N	-	Y,3	24.04.06	Y	N	N	Y	-	-	4	19	HHS 68	good	N	
29	Rajanila	38/M	gap nonunion	1	DF right	P. type B1	N	-	Y,1	28.04.06	Y	N	N	Y	1	-	5	16	-	fair	N	
30	Perumal	40/M	nonunion	15	DF left	P. type A2-1	N	-	Y,2	03.05.06	Y	N	N	Y	-	-	4	20	-	good	N	
31	Uma shankari	38/F	# calcaneum	7 days	Rt calcaneum	-	N	-	N	22.05.06	Y	N	N	Y	-	-	4	26	PSSSC 6/6	excellent	N	
32	aasai	27/F	CH	60	MEC 5th left	E. grade I	N	Y,2	N	01.06.06	Y	N	N	N	-	-	4	26	-	excellent	N	
33	Geetha	20/F	GCT multricentric	4	PPX left ring finger	E. grade III	N	Y	N	02.06.06,	Y	N	N	Y	3	-	4	15	-	fair	Y	
34	Chandran	55/M	caries spine with paraparesis	4	D9-10	paradiscal type	Y	Y	N	09.06.06	N	Y	Y	Y	-	-	3.5	24	Bridwell grade II	excellent	N	
35	Sumathy	35/F	GCT	1	DF right	E. grade II	Y	Y	N	14.06.06	Y	N	Y	N	-	-	3.5	25		excellent	N	
36	Malliga	45/F	caries spine with paraparesis	1	L3 vertebra	body type	N	Y	N	16.06.06	N	Y	Y	N	-	-	3.5	24	Bridwell grade II	excellent	N	
37	Boologam	55/F	non union humerus	8	PH right	P. type A1	N	-	N	28.07.06	Y	N	N	Y	-	-	3	22	-	good	N	
38	Mobarak	14/F	pathological # frmur	7 days	DF left	-	N	Y	Y,1	03.08.06	Y	N	N	Y	-	-	3	20	-	good	N	